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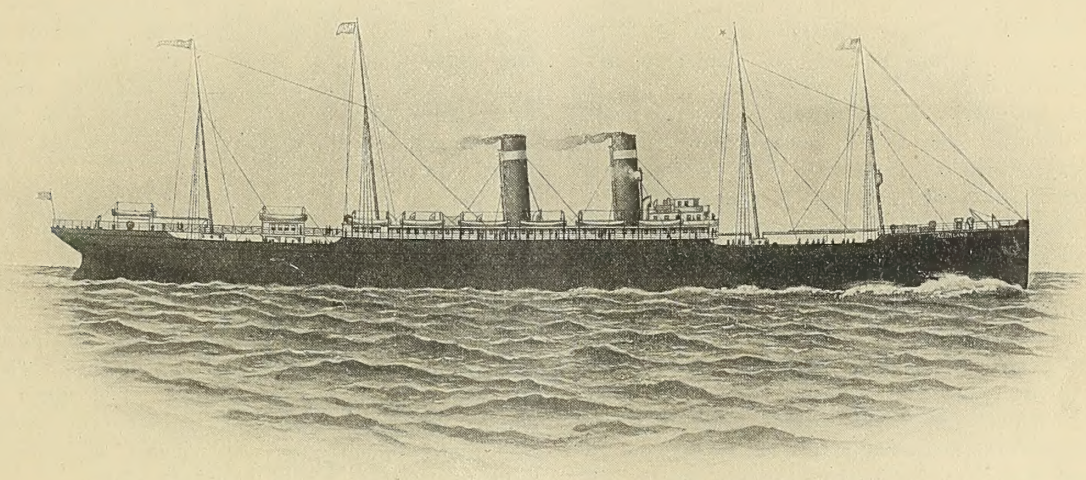
NEW TRANSATLANTIC LINER VADERLAND FOR THE RED STAR LINE.

The *Vaderland*, the first of the four new steamers for the International Navigation Co., to run on the Red Star Line between New York and Antwerp, arrived in New York on her maiden trip, December 20. This fine ship is of the intermediate type, with extensive passenger and cargo accommodations, and moderate speed. She is of the following dimensions: Length, 580 ft.; beam, 60 ft.; depth, 42 ft.; and gross tonnage, 12,000 tons, or slightly in excess of the tonnage of the *St. Paul* and *St. Louis*.



SEVENTEEN KNOT RED STAR LINER VADERLAND, BUILT AT CLYDEBANK.

The other vessels building for the line are the *Kroonland* and *Finland*, at Cramp's yard in Philadelphia,, and the *Zeeland* at Clydebank, Scotland, where the *Vaderland* was constructed. This vessel has been built to conform to the requirements of Lloyd's and of the American and British Governments, and she flies the British flag. There are 11 water tight bulkheads arranged so that the vessel would keep afloat with any two compartments filled with water.

The hold and 'tween decks of the vessel are devoted to the carriage of cargo and stores, with the exception of a space amidships comfortably fitted for the firemen, and of a small space aft occupied by stewards. There is cubic capacity sufficient for 11,000 tons of cargo, and tanks are provided for more than 200 tons of fresh water, in addition to what may be condensed en route. The storerooms are well arranged for the quantities of provisions that will be carried, and include refrigerated chambers for meat and other perishable articles.

At the forward end of the saloon deck, which is given up to passenger accommodation, are three compartments for third class passengers (the men's quarters), and at the after part of this deck are the compartments for the women and married third class passengers, who are berthed in staterooms containing two, four, or six berths. These quarters have well lighted dining rooms. Every compartment has a wide companionway leading to the houses on the upper deck which contain the lavatory and sanitary accommodation, and which give access to the promenades on that deck. On this deck, amidships, are staterooms for 106 first class passengers, and the first class dining

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saloon, which is situated between the funnels and extends the full breadth of the vessel. It can seat 204 passengers.

The woodwork of the first cabin dining saloon is white, enamelled in the Adams style and beautifully enriched, many of the panels containing handsome oil paintings. The furniture is mahogany, except the sideboards, which are of satinwood, tastefully inlaid with fancy woods. There is a piano of excellent tone in a case composed of rosewood and satinwood. For lighting and ventilation, in addition to the numerous side lights, there is an unusually large trunk well, extending through two tiers of decks, tastefully decorated in white and lighted through a richly ornamented glass roof. The seats are covered with a rose-colored moquette, and the upholstery throughout is in keeping with the color scheme of the other decorative materials.

Aft of this saloon, and between it and the second class dining saloon, are situated the galleys, sculleries and pantries, so arranged that ready service can be given to either class of passengers. The second class dining saloon comes next, and also extends the full width of the ship. It can seat 120 passengers and is panelled with tapestry upon a soft, cream-white ground. The furniture is mahogany, and carpets, cushions and curtains are in varying shades of one color, giving a very pleasing effect. There are staterooms for seventy-six second class passengers aft of this saloon.

Coming now to the upper deck and starting forward, there is a long forecastle fitted up for the accommodation of crew and petty officers, with hospitals and lavatories for steerage passengers. Amidships is a bridge house, 220 ft, long, with staterooms for 204 first class passengers at the fore end, and 120 second class at the after end. These staterooms are large and excellently lighted and ventilated. In a deck house aft is the social room for third class passengers.

The deck above is the promenade deck, which is sheltered by the permanent roof formed by the boat deck. On this promenade deck are situated the first class library and smoking room, as well as suites and special cabins. These rooms are in deck houses lighted by rectangular windows with ventilating stained glass panels in the upper part

Almost all the first and second cabin accommodations are located amidships in deck houses, the forward end of which is 192 ft. from the bow and the after end 172 ft. from the stern. This location places the rooms where the motion is least felt, and where the ports may be kept open in almost all weather.

The library is of large size, 36 ft. wide, and is painted in white enamel with panels of striped silk and silk upholstery. The windows are fitted with cloisonne glass panels. There is a beautifully designed book case in inlaid satinwood, a piano and convenient writing tables.

The entrance hall is spacious. The doorways and the staircase and paneling are in oak. Comfortable leather couches line the walls and the windows have leaded glass panels. A massive gilt grille gives a fine effect to the skylight over the staircase.

Aft of the entrance hall are cabins for 32 first class passengers, and also four special suites of cabins, each consisting of two rooms, with a lobby between, which communicates with the bathroom. These rooms are so arranged that they can be used either as sitting rooms or bedrooms as desired, and are fitted with small folding tables and other conveniences, as well as extension beds. All these rooms open into passages which are continued aft so as to lead under cover to the smoking room, which is situated just aft of the engine casings. Conveniently located on this deck and with a separate stairway to the deck below, are the barber shop, bath and lavatory accommodations for gentlemen. The smoking room paneling is in fumed American oak. The windows and skylight are enriched with leaded antique glass. The seats and cushions are covered with leather, and the floor with rubber tiling. A bar is arranged to serve direct into this room, and tables for card parties with all the usual smokers' conveniences are provided.

At the after end of the promenade deck, which is reserved for second class passengers, is a deck house containing the entrance hall and the ladies' room, the latter being in mahogany with panels of tulip wood and satin wood with a brightly painted ceiling. The second class smoking room is on a detached part of the promenade, reached by gangways. It is much larger than is usual and has rich warm mahogany walls, leather covered seats, and leaded glass panels to side and overhead windows.

There can be carried altogether 342 first class, 194 second class, and about 1,000 third class passengers.

The navigation officers' cabins are placed above the promenade deck and at the fore end of the boat deck; and above their deck house is the bridge, giving a clear view over the whole vessel and well sheltered by a strong steel bulwark. Part of the boat deck is apportioned as a promenade for the firemen, and is fitted with sheltered seats.

There are altogether twenty boats, including four patent collapsible ones. The lifeboats are all of steel and are carried in the usual manner, under davits. They are, of course, fitted with patent disengaging gear.

The arrangements for loading and discharging cargo are very complete. There are nine hatches, each having its own winch and derrick. The upper deck hatches are fitted with dished steel covers instead of the usual wooden ones. All winches, windlasses and warping capstans are of American make.

The ship is lighted throughout by electricity. The installation was fitted by the builders, as was also a complete system of electric bells. The generating plant is situated in a large room, convenient of access from the engine room, and consists of four dynamos, driven by engines built by the Sturtevant Co., of Boston, Mass.

The system of artificial ventilation is also by the Sturtevant Co., of Boston, and it is similar to the system installed on the *St. Louis* and *St. Paul*, where it has been very successful. Powerful fans exhaust the air from every room and compartment, and fresh air is drawn from above the bridge deck, and distributed throughout the passenger accommodations. Fresh air is thus constantly supplied, and in cold weather this air is heated by passing over steam pipes, and the heat

supplies may be regulated for each deck independently. By this system the inner rooms of the ship are as comfortable as the outer ones, the only difference between them being that the occupants of the outer rooms may get a glimpse of the water from the port holes. This system does away with the necessity of laying steam pipes in every room, which is one of the principal causes of what is known as the usual "ship smell."

The propelling engines are of the four cylinder, four crank, quadruple expansion type, with balanced moving parts. The order of the cylinders from the forward end is: High pressure, second intermediate pressure, first intermediate pressure, and low pressure; and the crank sequence is: High pressure, low pressure, second intermediate and first intermediate. The cranks are set 90 deg. apart. In diameter the cylinders measure: H. P., 31 in.; 1st I. P., 44 in.; 2d I. P., 62 in.; L. P., 88 in., and the stroke is 54 in. Piston valves are fitted to the high and intermediate pressure cylinders, and treble ported slide to the low pressure, and all are worked by Walschaert gear. This makes a short engine, the valve chests being placed on the backs of the cylinders—each engine is only 29 ft. long. Siemens-Martin steel is used for the crank shafts, which are built up, each in four interchangeable sections.

The condensers are built into the back of the engine frames, and the air pumps are worked direct off the second I. P. crosshead. There are also fitted two large evaporators to produce the necessary fresh water fram the sea water to make up the feed, and to avoid the use of salt water in the boilers. Two large feed heaters and filtering arrangements are provided. An auxiliary condenser has in addition been fitted on board with a separate circulating pump so that all the auxiliary machinery in the ship is worked separately from the propelling engines. An installation of Worthington pumps has been fitted on board.

There are eight single ended boilers in the ship, constructed of steel and adapted for a working pressure of 200 lb. per sq. in. There are four furnaces to each boiler, making 32 in all, these being Brown's suspension type. The boilers are fitted with "Serve" tubes 3 1-4 in. in external diameter. Ellis & Eaves' system of induced draught is fitted to the boilers.

The boilers are in two compartments, leading into two funnels, which are 98 ft. high from the grate level, and eliptical in plan, 13 ft. 6 in. by 8 ft. 6 in. The fans are eight in number, 7 ft. 6 in. diameter, and are driven direct by Sturtevant engines. These fans, situated directly under the funnels, induce a draught through the furnaces, the air having previously been heated by passing through tubes placed in the way of the waste gases from the furnaces. The inlet of air to the furnaces is through tubes placed in a casing over the boiler, thence down a passage in front of the smoke box at the end of the boilers and into the furnaces. The gases from the furnaces, after passing through the boiler, play around the tubes forming the air inlet and subsequently pass through the fans into the funnels.

The load draft of the *Vaderland* is 31 ft. 4 in. and the maximum speed 17 knots.

NEW BATTLESHIPS AND ARMORED CRUISERS FOR THE U. S. NAVY.

Among the papers presented at the recent meeting of the Society of Naval Architects and Marine Engineers was one by Chief Constructor Philip Hichborn, in which the various types of cruisers and battleships authorized by Congress during the two years past were described. In an abstract of that paper, included in our report of the proceedings at the meeting, in our last issue, we gave the chief points of interest of these vessels. We now supplement this by the drawing of our artist, showing the three classes of vessels for which bids have been or will soon be opened. These vessels include battleships, armored cruisers, and protected cruisers. The drawing of our artist has been prepared from original sketches kindly furnished to us by the U. S. Bureau of Construction and Repair.

It is proposed to make all the battleships flagships, by fitting them with acommodations for one flag officer, one commanding officer, one chief of staff, twenty ward room officers, twelve junior officers, ten warrant officers, and 658 crew and marines. The applications of electricity on board are very much wider than in the case of any other battleships in existence, with the exception, possibly, of the *Kearsarge* and *Kentucky*. All the turrets will be fitted with electrical turning gear, and the electric drive will be used also for the ammunition hoists, blowers for the turrets and general ventilation, the workshop machinery and all the auxiliaries outside the engineers' department, with the excepton of the capstan and steering gear.

The new armored cruisers will be a most important and necessary addition to our Navy, for since the construction of the *New York* and *Brooklyn* no ships of this type have been aded to our fighting ships. European powers have been developing this type of vessel, the English being in possession of the *Cressy* class, of which the *Aboukir*, described in one of our recent issues, is a representative. These vessels are 440 ft. long, 12,000 tons displacement, and of 21 knots speed, with a maximum of 21,000 I. H. P. They are sheathed and coppered. France has nearly completed the cruiser *Jeanne d'Arc*, which is also described in one of our previous issues. This vessel is about the same dimensions as the *Cressy* class, and is expected to attain a trial speed of 23 knots with 28,000 H. P. Germany has a good representative of this type in the *Furst Bismarck*, which has 10,600 tons displacement, and with 14,000 H. P. has attained a speed of 19 knots.

The new cruisers designed under the supervision of Chief Constructor Philip Hichborn will be very formidable vessels, and, in the opinion of many, will be superior to any ships of similar type abroad. They will be capable of keeping sea for long periods, as there will be bunker capacity for 2,000 tons, and three of them will be sheathed. The maximum speed is high, being not less than 22 knots. Each vessel will be equipped as a flagship, and the complement of officers and men will be 822 all told. In their construction the use of wood will be restricted greatly, and it is probable that even metal furniture will be used to a considerable extent. As in the case of the battleships,

SUMMARY OF BIDS ON BATTLESHIPS

A.—(3) SHEATHED BATTLESHIPS—ACT MARCH 3, 1899—APPROPRIATION $3,600,000 EACH.

Bidder.	Ships.	Amt. of Bid.	Value of Articles omitted from Specifications.	Total of Bid.	Standing of Bid in regard to Price.
J. H. Dialogue & Son	1	$3,400,000	.....	$3,400,000	1
Fore River Co.	1	3,580,000	.....	3,580,000	2
Fore River Co	2	3,555,000	.....	3,555,000	1a
Bath Iron Works.	1	3,590,000	167,500	3,757,500	3
Newport News.	1	3,593,000	167,500	3,760,500	4
Cramp & Son.	1	3,600,000	167,500	3,767,500	5
Moran Bros.	1	3,865,000	.....	3,865,000	6
Moran Bros.	2	3,749,000	.....	3,749,000	2a
N. Y. Ship Bd. Co	1	4,200,000	.....	4,200,000	7
N Y. Ship Bd. Co	2	4,175,000	.....	4,175,000	8

There were certain reservations made for outfits and for coppering the ships by the government which added to bids makes all of these bids but that of Dialogue & Son exceed the appropriation.

B.—(2) UNSHEATHED BATTLESHIPS—ACT JUNE 7, 1900—APPROPRIATION $3,600,000 EACH.

Bidder.	Ships.	Amt. of Bid.	Value of Articles omitted from Specifications.	Total of Bid.	Standing of Bid in regard to Price.
Dialogue & Son	1	$3,290,000	.....	$3,290,000	1
Fore River Co	1	3,430,000	.....	3,430,000	2
Fore River Co	2	3,405,000	.....	3,405,000	1a
Moran Bros	1	3,697,000	.....	3,697,000	4
Moran Bros	2	3,586,000	.....	3,586,000	2a
Union Iron Works.	1	3,460,000	178,500	3,638,500	3

The reservations on these vessels make all bids but those of Dialogue & Son and Fore River Co. exceed the appropriation.

SUMMARY OF BIDS ON ARMORED CRUISERS.

A.—(3) ARMORED CRUISERS SHEATHED—ACT MCH. 3, 1899—APPROPRIATION $4,000,000 EACH

Bidders.	Ships	Amount of Bid.	Standing of Bid in Regard to Price.
Union Iron Works	1	$3,800,000	1
Newport News.	1	3,885,000	2
Cramp & Sons.	1	3,890,000	3
Fore River Co.	1	3,975,000	4
Fore River Co.	2	3,950,000	1a
Moran Bros.	1	4,132,000	5
Moran Bros.	2	4,008,000	2a

The reservations on these bids make all but those of Union Iron Works, Newport News and Cramp & Sons exceed the appropriation.

B—(3) ARMORED CRUISERS—UNSHEATHED—ACT JUNE 7, 1900—APPROPRIATION $4,250,000 EACH.

Bidders	Ships	Amount of Bid.	Standing of Bid in Regard to Price.
Union Iron Works.	1	$3,750,000	1
Newport News.	1	3,775,00	2
Cramp & Sons	1	3,780,000	3
Fore River Co.	1	3,800,000	4
Fore River Co.	2	3,775,000	1a
Dialogue & Son.	1	3,825,000	5
Moran Bros	1	3,963,000	6
Moran Bros	2	3,844,000	2a
Risdon Iron Works.	1	4,075,000	7

All bids with reservations added come below the appropriation.

the electric drive will be used for the gun and ammunition gear and for a great variety of auxiliaries.

In the accompanying tables the competitive bids for the construction of these vessels are tabulated. When the 11 vessels are complete, ready for sea, they will represent an expenditure of about $50,000,000. After consideration of the bids by the Board of Construction, the following distribution of the work was made by Secretary of the Navy John D. Long.

William Cramp & Sons Ship and Engine Building Co., Philadelphia, Pa., one sheathed battleship, $3,600,000; one sheathed armored cruiser, $3,890,000; one unsheathed armored cruiser, $3,780,000. Total, $11,270,000.

Newport News Shipbuilding and Dry Dock Co., Newport News, Va: One sheathed battleship, $3,593,000; one sheathed armored cruiser, $3,885,000; one unsheathed armored cruiser, $3,775,000. Total, $11,253,000.

Union Iron Works, San Francisco, Cal.: One sheathed armored cruiser, $3,800,000; one unsheathed armored cruiser, $3,750,000. Total, $7,550,000.

Bath Iron Works, Bath, Me.: One sheathed battleship, $3,590,000.

Fore River Engine Co., Weymouth, Mass.: Two unsheathed battleships, $3,405,000 each. Total, $6,810,000.

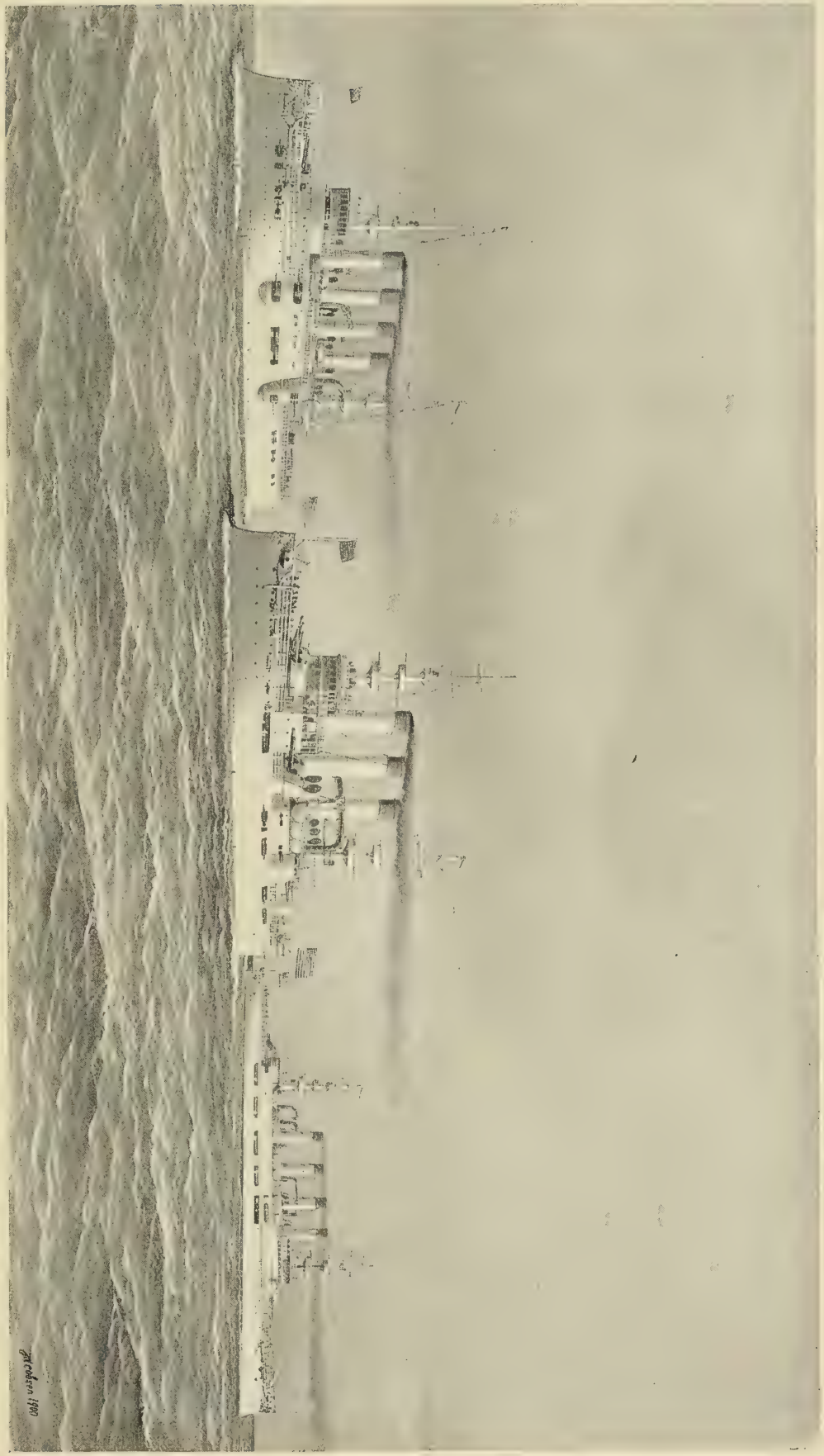
It is probable that some readjustment of bids will have to be made, owing to the fact that some of the bids did not cover all the equipment of the vessels provided for in the Appropriation Act, but this, it is understood, will not change the actual awards for the construction of the vessels as given.

Another type of vessel shown in our artist's drawing which will be added to the Navy is the *St. Louis* class of protected cruisers. These vessels approach more closely the armored cruiser in design than what has hitherto been regarded as the protected cruiser. They will be of 9,700 tons trial displacement, and with 21,000 I. H. P. are expected to attain a speed of 22 knots.

Some criticism has been made regarding the design of these vessels, which would make it an impossibility for any contractor to profitably undertake their construction within the limits of the Congressional appropriation. As an explanation of this, it has been suggested that the intention was to have vessels constructed in Navy Yards and not by private contract.

LOSS OF U. S. S. YOSEMITE.—The U. S. auxiliary cruiser *Yosemite* was lost in a typhoon off the harbor of San Luis d'Apra, Island of Guam, about the middle of November. The *Yosemite* was at anchor when she was struck by the typhoon, and dragging her anchors, she went on a reef, but came off and drifted about for nearly two days, being kept afloat by the pumps. An attempt was made to tow her to port by the collier *Justin*, but the *Yosemite* was so badly damaged that she had finally to be abandoned, and sunk, those on board being transferred to the *Justin*. When the *Yosemite* was first adrift, a launch which was sent out from the ship capsized, and five members of the crew were drowned.

At Dundee, Scotland, there is under construction a vessel to be named the *Discovery*, which will be employed in the projected National Antarctic expedition.



TYPES OF THE BATTLESHIPS, ARMORED CRUISERS AND PROTECTED CRUISERS INCLUDED IN THE PRESENT SHIPBUILDING PROGRAMME OF THE UNITED STATES NAVY.

COMPETITION IN LARGE VESSEL CONSTRUCTION—AMERICAN, GERMAN AND BRITISH.*

BY GEORGE W. DICKIE.

I am presenting this paper to the Society in response to a request received from the Secretary before starting out on a trip to Great Britain and Europe, the object of which was partly to note what advantages the shipbuilders there had over ourselves, either in skill, labor, or material, that would enable them to produce these great ocean freight and passenger carriers at less cost, or with greater certainty as to results, than ourselves.

This paper is being written on board one of the latest examples of the shipbuilder's art in that combination of great cargo capacity and a moderate amount of very comfortable passenger accommodation combined with a speed that was considered fast not so many years ago. The S.S. *Saxonia*, on which I am writing this paper, is the embodiment, I think, of a higher type of skill in naval architecture than those vessels wherein everything is made subordinate to the one sought for quality of speed.

This type of ship will, I believe, become the most important in the future extension of American shipping. Here is a vessel that carries 9,000 tons of freight at 15 1-2 knots on a coal consumption of 145 tons per day, or 1,200 tons of fuel used to carry 9,000 tons of cargo across the Atlantic, and at a speed that secures a large passenger patronage. Now the secret of obtaining this result is, first, the great increase in the size of ship, and, second, fitting engines of just the size required for the speed. The old idea of having a large surplus of engine and boiler power that the owner can never afford to run at its full capacity is a thing of the past, and ships are now designed with just sufficient power to meet the conditions as required by the trade in which they are to engage. Increased efficiency of engines and boilers has also helped in this astonishing result.

The question that forms the subject of this paper is one that has ever been present to my mind while visiting British yards and talking with British shipbuilders, and in trying to find an answer I have endeavored to compare ourselves with them in the three factors that enter into production: Skill in design, cost of labor, and cost of material.

In regard to skill, I have always found it difficult to make any just comparison between the product of one shipbuilder and another, the term meaning different things to different people. Skill in design must in merchant work have the commercial element as a prominent factor, and must embrace both the financial interests of the shipbuilder and the shipowner, and in order to prevent these interests from injuriously affecting the interests of the shipper who entrusts his property on the vessel and the interests of the underwriter who insures the interests of the shipowner and merchant. Certain societies representing all the interests involved hedge the designer about with rules that give him but a very narrow field which to exercise his skill as a naval architect. Yet, narrow as this field is, the progressive shipbuilders of Europe are continually pushing out the barriers, and forcing the recognition, by the registration societies, of new methods in construction, new properties that experience has shown to be desirable, and new combinations that have transformed, within the past few years, not only the dimensions of the ships built, but the whole method of construction. So that, hampered on every side as the naval architect is, by rules and traditions, his skill has been ever on the alert for the smallest opportunity to push out still farther the barriers set up against him.

In thus stating the obstacles that oppose the exercise of the naval architect's skill in design, I do not set these obstacles down as opposed to progress, but as limitations to the free exercise of the skill in design that many naval architects, and especially those of America, think they possess. When the ambitious young naval architect studies the rules, say of Lloyd's Register of British and Foreign Shipping, his first impression is that those people who make and maintain these rules are opposed to all progress, and imagine that they and the rules they have made represent the consummation of all that is possible in shipbuilding. As he gains experience, however, in his work, this first impression of his will be modified.

I have lately had to discuss with the chief surveyors at Lloyd's certain departures, that we considered slight and in the line of improvement, from the rules as applied to two large freight twin screw steamers we are now building. I have found that the skill of the experts at Lloyd's, and the careful study of every proposition made to them, not only protects all parties, but insures a steady forward movement, consistent with the proper protection of all the interests involved.

I believe, however, that an American register of shipping, that would be accepted by the shipowner and by underwriters the world over, would be a great help to the American shipbuilder, as it would no doubt lend itself more readily to the tendencies of American design. The British ship is the result of British experience, gained by British shipowners and sailors, embodied in British designs by the British naval architect, finally taking form in British shipyards; the result carrying with it much of the traditions and practice of the people and place where the work is done.

Now, can we in America do better than this? We are very likely to do a little different, as much different probably as the limitations referred to will allow, and these differences will, I think, take the form of a closer adaptation of the material used to its place and function in the complete design.

In this the steel manufacturer will likely take a share. As he becomes better acquainted with the special needs of ship construction, we will find him ready to undertake new sections better adapted to take the strains and stresses of ship structure, and reducing built up work to a minimum. We are on this point now abreast of the British builder, and, in methods of handling, ahead of most of them. In skill I think the American naval architect is quite abreast of his British cousin, and if he has plenty of practice there need be no fear of him keeping in that position.

In some of the great shipyards of Britain and Eu-

*A paper read at the Eighth General Meeting of the Society of Naval Architects and Marine Engineers, held in New York

rope they have acquired a greater experience in the production of the largest ocean steamships, both for passengers and freight, than we have; but we are in the way of obtaining this experience, and it will come to us just as it came to them, by a steady and skilful application of what we now have.

I find, also, especially among the younger naval architects in Britain, an opinion they are ready enough to express, that the United States is to be in the near future a rich field for the practice of their profession. I have found this opinion naturally strongest among those who feel the limiting power of British shipbuilding traditions strongest. Such men, if they come to our side, will have an effect in molding what may become American traditions in the future history of the art.

Granting, therefore, that there is nothing lacking in skill on the part of our designers, how are we in regard to the second factor in the problem of competition—that of the cost of labor? This is the one factor that presents the greatest difficulty in dealing with the problem of relative cost as between the shipyards of Great Britain and those of America. We work under different conditions in regard to a large portion of the work. The whole steel work of a ship may be said to be done under the piece-work system in Britain, the price per unit being fixed for certain shipbuilding districts between the shipbuilders and the unions representing the men. This method has its advantages, as it simplifies the estimating—a certain known portion of the work having a certain fixed value. While a considerable portion of the work with us is done on some piece-work system, every yard appears to have its own way of fixing prices with the men.

In the British yards, as with us, while practically all the steel work is done under some kind of piece system, yet on inquiry it appears that it is with them very much as it is with us; the number of men on wages on the very work supposed to be done by piece is greater than that of the piece-workers, and skill in management is directed to the reduction of the number of men on wages as compared to the number on piece-work.

From combining what information I have been able to gather, I find that on an average the steel work of construction cost in the British yards from £3 17s. to £4 per ton of material worked. This I think we can about equal in labor cost here. But when it comes to fitting out, including carpenter and joiner work, painting, and general finish, where piece-work does not cut any figure, the cost, I think, is directly as the wages paid. We employ the same class of men as they do; in fact, our best men come from the British yards, and while in some of our yards we may have some advantages in climate, this does not apply to all, and where we are paying 50 per cent more wages, the cost of labor that is reckoned in wages will be 50 per cent more here than it is in the British yard. And if half the labor cost for any given ship built in a British yard is paid in wages—and this is very nearly correct—and that half costs 50 per cent less than the corresponding part in our yards, our total labor cost will be 25 per cent greater than theirs. This is very nearly correct, as tested by comparisons I have been able to make of actual costs as between our yard and one or two in Britain, where I have been furnished with labor costs. I am convinced, however, that although we pay higher wages to our office staff of draughtsmen, that part of the work does not cost any more than in the British yards, as we seem to be able to do a like quantity of work with a smaller force.

The managing staff in our yards are, I think, paid less than corresponding officers in the large yards there, and they devote much more time to their duties.

As to what we may be able to do in regard to equalizing the cost of labor as between our yards and those of Great Britain, I do not think that it will be brought about by any attempt to equalize the rate of wages paid throughout the shipbuilding world, but I have hopes that some of our rising shipbuilders among the younger members of our profession may be able to devise some method whereby every part of a ship, both hull and machinery, will have a labor value fixed for it that will not exceed what such a piece of labor costs elsewhere, and that whoever, by his labor, contributes to the production of that piece shall receive as recompense his portion, that is, the percentage that his labor represents in the total labor required to complete the part on which he worked.

Something of this kind must be the foundation on which any true settlement of labor values must rest, and as it is done now with eminently satisfactory results in some of the most prosperous machine manufacturing establishments in England, it only needs the right kind of skill, honestly applied, to make it work in shipbuilding and engineering establishments in this country. I am so impressed with this, to me the only just way of recompensing labor, that were I twenty years younger I should take it up as a life work.

I find that the marine engine and its boilers cost less in proportion to the hulls than they do with us. This is no doubt due to the fact that neither there nor here does piece-work prevail in the production of the marine engine or its boilers, while machinists and boilermakers receive at least 50 per cent more wages with us.

In small tools I think we are better equipped than the engine works attached to the large shipyards there, but in heavy tools we are not better off thar they are.

Some prominent engine builders in this country seem to be able to compete with engine builders in Great Britain, sending their engines to the very centers of engine building in that country, and, so far as we know, with profit to themselves. At least they continue doing it, which would indicate that it is profitable. If this can be done with land engines it can also be done with marine engines, but not on present methods. We must be content without the professional luxury of introducing some engineering novelty with every ship we engine.

I do not say that we should be satisfied without making substantial progress in marine engineering, but healthy progress is not inconsistent with a standard system of working that would greatly reduce the labor cost of producing a modern marine engine.

In a large and prosperous engine works that I visited in England, building a special type of engine, but in all sizes from 10 to 3,000 H. P., I found that the term erection was not used. Every part of their engines is made to gauge, and when finished from the tools is sent to an expert examiner at a large surface table, with accurate measuring instruments, whose business it is to determine if every operation performed by the tools on that piece has been accurately done; that every hole has been bored properly; that every face is in its proper plane. He signs the workman's card that did the work if it has been done correctly; if not, the work is returned to him for correction, or rejected if it cannot be corrected. Every piece of work has a fixed labor value. Every man gets his regular wages. If the work he produces exceeds in labor value the wages, he is credited with 50 per cent of the difference. If the labor value of his work is continually less than the wages paid him he cannot continue to work in that establishment. The pieces thus produced that go to make an engine when brought together are not erected as we do, fitting each piece to its place by file or chisel, as may be, owing to defective tooling; but they are placed in stock ready to be assembled in a few hours on receipt of an order for an engine of the size they represent. A system to insure correct tooling on every piece entering into the construction of our marine engines would, in my opinion, reduce the cost of erection by one-half. Some such system, and making every man a partner, so far as the result of his own labor is concerned, would place us in marine engineering where we are now in the production of land engines.

If we are to pursue the same methods as we are now doing, which are just the same as those that prevail in the shipbuilding and marine engineering centers of Great Britain and Europe, our labor costs will be very nearly in proportion to the rate of wages as compared with theirs. But in the development of some plan whereby we can fix a labor value for all our work that will not exceed theirs lies our salvation, and the American workman would, in my opinion, profit largely by the general adoption of some such plan.

On our present methods our labor cost is, as near as I can compute it, 25 per cent greater on the hull and 50 per cent greater on the machinery of an average ocean going freight and passenger steamer. I trust this statement will be carefully discussed by any member of this Society who has any knowledge on this question of labor costs, for much of our future progress in shipbuilding depends upon how we are able to solve it.

In regard to the cost of material, I am afraid that this part of my subject is beyond my ability to in any satisfactory way compare our conditions with those of the British or European shipbuilder. The most important material affecting the cost of shipbuilding is steel, and the tremendous fluctuations that at times take place in the price of that material in this country is the most serious question we have to contend with in trying to predict anything in regard to the future of shipbuilding in this country. The tariff on steel plates and shapes makes it possible for us to find the British shipbuilder working into his ships American steel from Pittsburg at a less cost to him than the English material, and at less cost than is charged the American shipbuilder for the same material in Pittsburg. I saw in a yard on the east coast of Scotland steel being worked into a vessel that was delivered in the yard from Pittsburg at less than £7 2s. 6d. per long ton. If the American steel manufacturer can meet the British steel manufacturer on equal terms in the British shipyards, somehow it seems as if it might be possible for the American shipbuilder to get his steel material as cheap as the British shipbuilder gets his. This is all that I possible can advance on this part of my subject. As the duty on steel of this character is not a protective measure, and cannot possibly produce revenue, it should not be maintained to render wild fluctuations in price possible.

I may be wrong, however, as to the cause of the immense variations in the price of steel here, but I think I am right in saying that such conditions relative to the most important material he uses are a great obstacle to the progress of the shipbuilder in this country. Engine and other forgings cost more with us than they do in Britain and Europe. In ordinary forgings of steel this difference is from 30 to 50 per cent, and in high grade forgings, such as required by our Navy Department specifications, there is no comparison. The usual extra charge for nickel steel forgings in Britain is £4 per ton extra for each 1 per cent of nickel in the steel. I did not find nickel steel forgings being used at all in merchant work.

On the whole, I think the British builder has an advantage over the American builder in the cost of material. This applies even to the wood used, As near as I can judge at the present time, there is 10 per cent in cost of material in favor of the British shipbuilder as compared with the cost of material in American yards.

From the foregoing, if the statements I have made are correct, we are not yet in a position to compete with the shipbuilders of Britain or Europe, Europe meaning Germany only I think, in this connection, the difference being not less than 15 per cent on the finished ship.

As we gain experience and adopt new methods, especially in regard to the management of that most important factor, labor, this difference may ultimately disappear. Some wise legislation will have to be devised that will enable the American shipowner to build his ships here, although costing somewhat more until we have found out the way to pay American labor to build American ships that will not cost more than the British ship built by British labor.

I am conscious of the fact that, although I have tried to place this subject fairly before the Society, I have failed to present it in any new light. Somehow it belongs to that class of subjects that cannot be demonstrated by any statement of facts, as facts in one place are not facts in another, and facts to-day are not facts to-morrow.

ADDITIONAL PARTICULARS OF THE FLOATING DRY DOCK FOR ALGIERS, LA.

In a previous article, our readers will recollect, we gave a general description of the new U. S. floating dry dock for Algiers, La., now under construction at Sparrow's Point, Md. Since that article was published work on the dock has gone on apace, and the huge structure is now so far advanced that some additional particulars and details of the actual construction will be of real interest.

The original plans of the dock were drawn by Messrs. Clark and Stanfield, of London, England, who are specialists in this branch of naval architecture, and who were the designers of the huge floating docks at Stettin, Germany, and Havana, Cuba. Modifications and improvements were made in the original plans to meet the requirements of the U. S. Bureau of Yards and Docks, the details being worked out by the dock construction department of the Maryland Steel Co. The structural strength throughout the pontoons was increased, giving the dock a maximum capacity of 18,000 tons when the deck or floor is awash, or of 15,000 tons with a free board of about 2 ft.

The modified specifications require that the dock shall have a transverse strength and stiffness sufficient for docking a battleship of 15,000 tons, with the entire weight carried on the keel blocks. The dock must not careen more than 3 deg. under the most unfavorable conditions of loading—the vessel landing 2 ft. off the longitudinal centre or subject to a wind pressure of 30 lb. per sq. ft. The greatest longitudinal deflection allowable is 1 in 3,000, with the most unfavorable load, and similarly the greatest transverse deflection is limited to 1 in 1,800. Carrying a 15,000 ton battleship 2 ft. above water, the stability of the two combined will be from 15 to 20 times that of the ship floating in the water. The time required for lifting a vessel shall be 3 1-2 hours from the time the keel is centered on the blocks.

The question of the lifting power recalls one of the advantages of a floating dock. When docking a vessel in a graving dock the whole of the contents less the volume of the ship has to be removed by pumping, therefore, the smaller the ship in dock the greater the amount of water to be lifted, and when it has to be emptied merely to prepare the berth for a ship, the whole amount has to be pumped out.

In a floating dock, on the contrary, the ship being supported by the buoyancy of the dock, the weight of water to be removed is only proportional to the weight of the ship, plus an amount representing the dock itself, whilst when the dock is lifted light to prepare the berth, only its own weight has to be dealt with. The saving thus effected is very considerable, and is not only apparent in the reduced first cost of the pumping plant, but remains constant throughout the life of the dock in the form of a reduced coal bill.

The dock consists of five portions, comprising three pontoons as the lifting portion of the dock and two side walls, which, whilst affording a certain amount of lifting power, primarily serve to give the dock stability and to regulate its descent when the pontoons are submerged.

For purposes of reference, we give the general dimensions of the dock as follows:

Length over all	525 ft.
Breadth over all	126 ft. 2 7-16 in.
Breadth between walls	100 ft.
Depth over sills	28 ft.
Depth of pontoons	17 ft. 6 in.
Heighth of keel blocks	4 ft.
Maximum draft	49 ft. 6 in.
Number of pontoons	3
Length of middle pontoon	240 ft
Length of end pontoon	141 ft. 3-8 in.
Length of walls	395 ft. 5-8 in.
Width of walls	12 ft. 1 1-8 in.
Clearance of walls and pontoons	2 ft.
Freeboard of walls 28 ft. on sills	4 ft. 9 in.
Number of keel blocks	261
Weight of dock	5,855 tons
Equipment of dock	1,000 tons
Total weight	6,865 tons

The pontoons themselves are of different sizes and form, the centre one is 240 ft. and rectangular in shape, but the two terminal pontoons have a parallel body for about 80 ft. of their length, the remainder being finished off in the form of a blunt nose or bow. For a length of 110 ft. these end pontoons are buoyant and the remaining length, forming the point proper, is formed by a series of plate and lattice girders of strong construction. Each pontoon has three longitudinal bulkheads, the two outer ones being watertight, whilst the middle one is designedly left with small openings. This central longitudinal bulkhead is intercostal between the transverse bulkheads, having two vertical plates connected to the first and second intermediate frames by angles. These longitudinal frames are placed 2 ft. 6 in. apart and are of a girder design. each frame calculated to withstand a strain of from 40 to 65 tons load per ft. This construction is carried throughout the entire central portion of all the pontoons covering the area for the required stability for carrying the heaviest battleship now built. 'Thwartship bulkheads are introduced every 10 ft., every fifth and sixth being watertight. The deck floor of the pontoon is carried up 8 ft. in the shape of altars to give increased stability.

Keel blocks will be placed on keel sills 2 ft. apart and bilge block sills running athwartship every 4 ft. These are extended every 16 ft. for the entire width on both sides of the keel block sills, and provided with adjustable sliding bilge blocks with racks.

Side walls are similarly constructed with five transverse bulkheads and frames and provided with two gangway openings on each side. These walls are connected to the pontoons by steel castings with fish plates and secured together by taper pins and bolts.

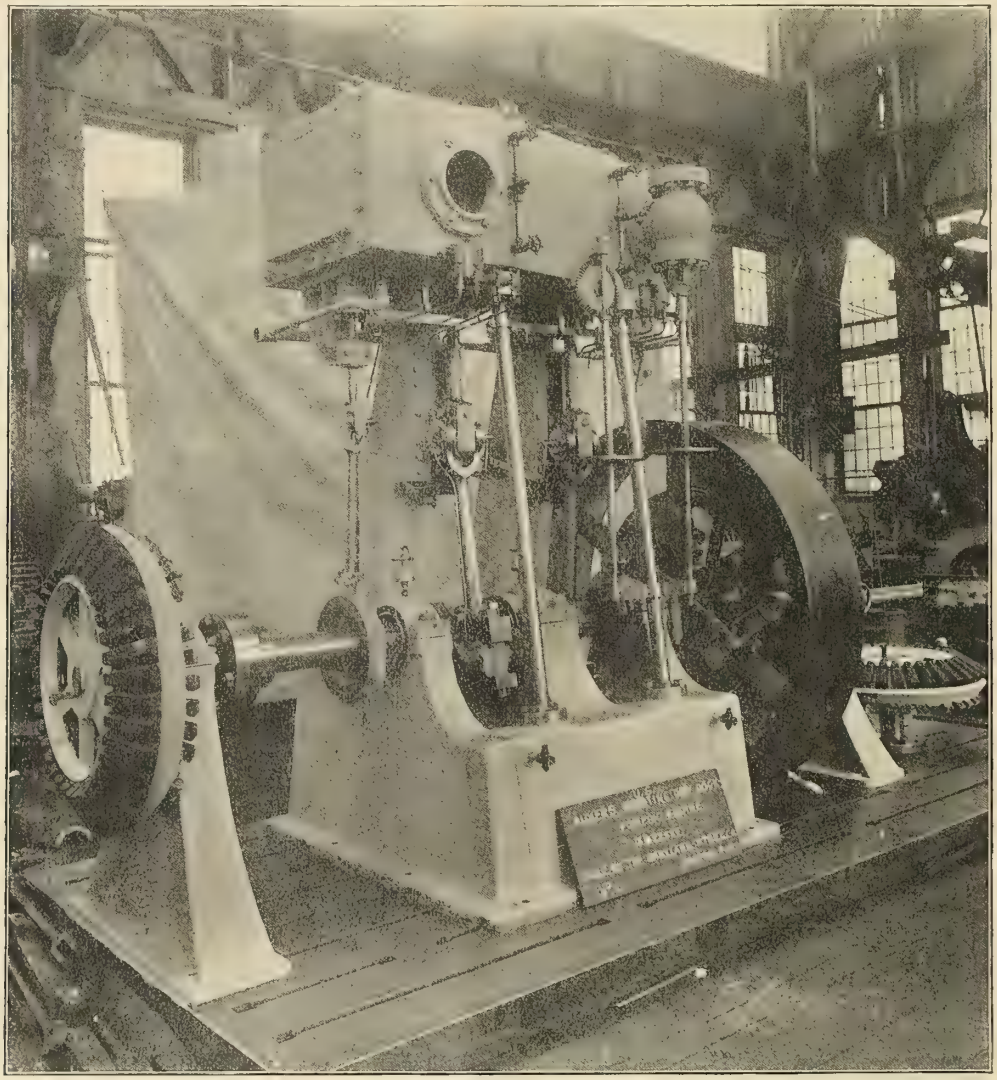
The operating machinery consists of engines, boilers and pumps, which are installed in the walls, each wall containing a separate and complete plant within itself.

The main pumps are placed in the bottom of (four in each) the walls and connected by vertical shafting and gearing to engines which are of the compound type. These are furnished with automatic fly wheel governors of special design that not only regulate the engine and maintain a determined speed by automatically changing the cut off as the steam pressure or load may vary, but also vary the rate of revolutions at will, from a minimum of 200 to a maximum of 300 revolu-

tions, without stopping the engine. The governor regulates at either extreme or at any intermediate speed desired, and in this respect differs from the ordinary shaft governor. The object of the differential speeds is to give the centrifugal pumps their highest efficiency speeds working under different heads.

The steam plants on the dock will be complete in every detail, and will include washing down and drainage pumps. The actual mooring of the dock will be by four chain cables, of the stud link pattern, to which will be attached mushroom anchors. These will be handled by heavy capstans connected to powerful winches, built by the Hyde Windlass Co., and placed on the top deck of the side walls. The dock will also be attached to two shore steel columns by two steel lattice booms, articulated in all directions, the dock being free to rise and fall with the river, which is subject to frequent severe freshets, sometimes rising 20 ft. above Gulf level. This connection will at the same time allow the dock to be swung in shore out of the strongest current, which occasionally attains a speed as high as six miles an hour.

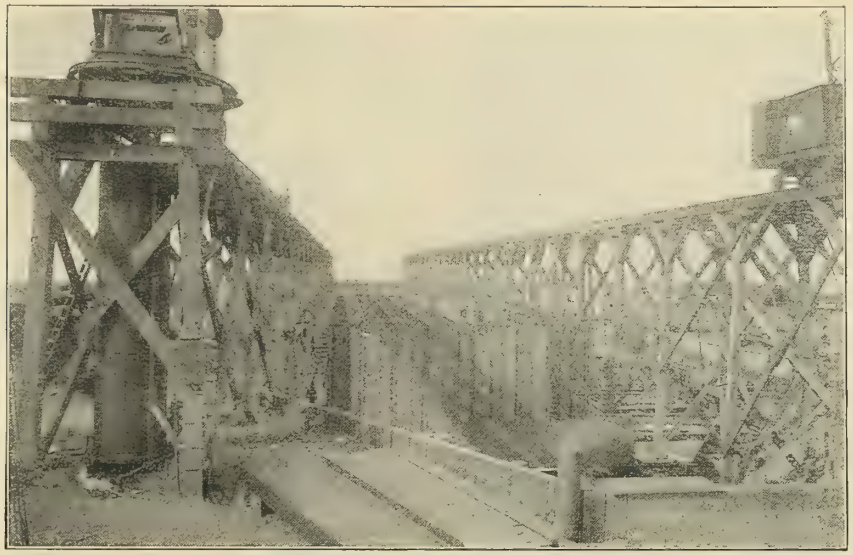
The side walls are provided with a flying gangway, which is placed at the bow end of the dock, and hinged so as to swing together. It will be fitted with a platform and handrailing, thus providing a means of passing from one side wall to the other. There are also on the inside of the side walls convenient ladders and stairways to reach the upper and intermediate deck from the deck of the pontoons. Each gangway deck and opening is proivded with light swinging hand cranes for handling material from off shore connections or from lighters. On the top of the walls there will also be placed auxiliary winches, fairleads, and all the necessary appliances for handling lines for docking a vessel.



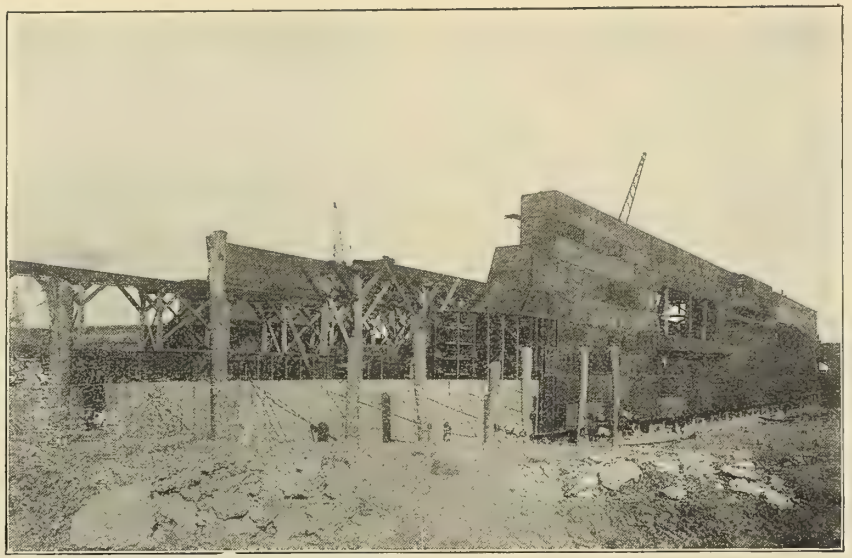
TYPE OF PUMPING ENGINES FOR U. S. FLOATING DOCK.

The operating valve houses are located on the top deck of each side wall, from which positions the entire handling in docking a vessel is carried out. There are also four mechanical side shores, two in each wall, so that a vessel can be easily and directly centered over keel blocks.

A feature of the floating dock is its self-docking capacity, so that at any time any portion of it can be

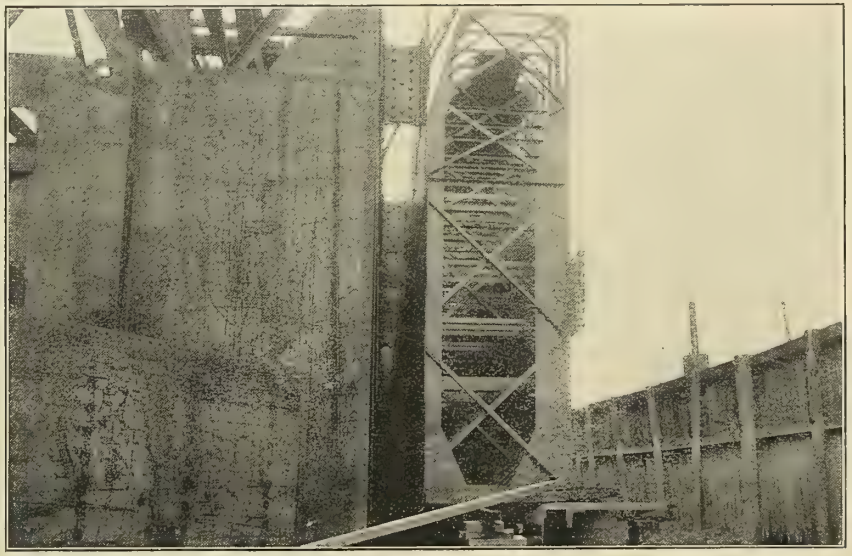


View from stem showing bulkhead plates.



View from port side.

Basin ready for dock construction.



Joint connections in place.

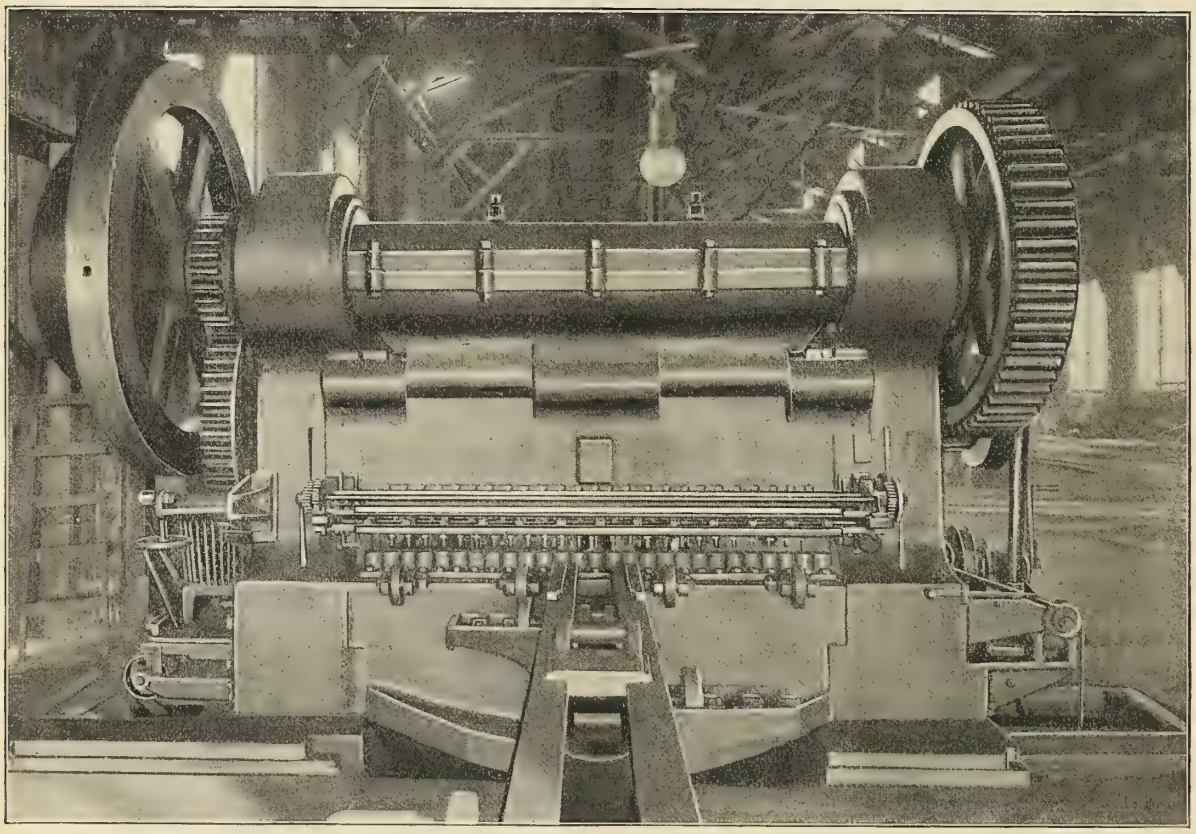
VIEWS OF THE UNITED STATES FLOATING DRY DOCK FOR ALGIERS, LA., IN PROCESS OF CONSTRUCTION AT THE MARYLAND STEEL CO.'S SHIPYARD, SPARROW'S POINT, MD.

made readily accessible for inspection or repairs. To reach the bottom of one of the walls, say the port one, it is only necessary to heel the dock to starboard.

In the case of the pontoons, the middle one is made large enough to raise those at the ends out of water. Suppose it is desired to get at the bottom of the middle pontoon, the dock is allowed to float light, men then knock out the tapered pins of the two rows of fish plates which secure this pontoon to the side walls; then the dock is allowed to sink, the middle pontoon floating free until the lower row of fish plates on the pontoons is level with the upper row on the walls; the pins are then driven in, the dock pumped out and the middle pontoon is lifted clear of the water—due to the difference in height between the rows of fastenings. To undock, the reverse course is followed. The end pontoons are similarly treated. The interior of the walls and pontoons is easily accessible through numerous manholes.

Should a disabled ship draw one or two more feet than the capacity of the dock permits, the dock master would not hesitate to sink the dock extra depth, as the walls have a minimum freeboard of 4 ft. 9 in. Also, should a ship, from any cause, have a list, the dock could be given the same list within limits, the ship taken in, and the two then brought to an even keel.

Before the actual construction of the dock was commenced a good deal of preliminary work had to be carried out, necessitating an outlay of about $100,000. After contracts had been placed with the mills for about 5,800 tons of steel material, the berth for the construction of the dock was made by excavating and dredging some 50,000 cu. yds. on the water front adjoining the present shipyard of the Maryland Steel Co. Part of the material excavated was used for the construction of a coffer dam, which, when the dock is completed, will be removed and the dock floated from the basin, thus avoiding any stresses due to launching from ways. The foundations to carry the dock, while under construction, consist of deep piling, carrying heavy timber sills and blocking, on which are laid heavy steel rails. On these the bottom plates of the dock were laid down. On the ground surrounding the basin, tracks were laid, and these were extended throughout the yard, so that the material as it was received from the mill could be conveyed direct to the machine shop and thence to the basin for erecting. The movement being all in one direction practically reduced the rehandling of the material to a minimum.



MULTIPLE PUNCH USED IN CONSTRUCTION OF THE UNITED STATES FLOATING DOCK AT SPARROW'S POINT.

Two lines of trestles were erected, as shown on the accompanying photographs, equipped with electric overhead traveling cranes. For machining the structural material a shop 250 ft. by 65 ft. was erected and equipped with the most modern machinery for punching, shearing and bending plates and angles, and for planing edges, the latter machine having a capacity for 12-ft. plates. The most interesting and novel machine in the equipment was an immense multiple punch, shown in the photograph on this page, by which nearly all of the plates used in the construction of the dock have been punched. This machine is capable of punching plates 30 ft. long, 7 ft. wide and 3-4 in. thick,

and to any spacing required. It is provided with an automatic feed and spacing device, operated by means of levers, cut beveled gears and a double thread feed screw, so that by a change of gears any desired pitch can be obtained. The punch is driven by a 15 H. P. electric motor at a speed of 16 revolutions per minute, and the plates are punched at the rate of 4 lineal ft. per minute when 3 in. pitch is used. The punches are manipulated by a system of bar levers and gags, so arranged that any combination of punches can be made to punch through the plates or remain idle at the will of the operator. The plate travels on a bed of rollers and is drawn by a driving carriage attached to the feed screw. The after end of the plate is also held to center by a carriage. The center line of the plate is the only marking required, so that it can be set fair in the carriages, and there is no need for templating or marking on the plate. The spacing being automatic, the work turned out is absolutely correct and little or no reaming is required when erecting in position.

The machine tools in the Dock Department are electrically driven and the shops are all lighted by arc lamps. There is also a compressed air service, with piping laid along side of the dock, all riveting, caulking and chipping being done by pneumatic tools.

About 300 men are now engaged on this structure, which is expected to be completed early in the coming spring. The shore work at Algiers, La., is also well under way, and will be completed in February.

The entire work is in charge of Sven Anderson, general manager of the dock construction department. George H. Hewes is resident inspector for the U. S. Government.

Navy Report.—Secretary John D. Long, in his Annual Report, just issued, renews his suggestion that the Bureaus of Construction and Repair, Steam Engineering and Equipment be consolidated into one Bureau, to be known as the Bureau of Ships. He also calls attention to the necessity of an increase in numbers in the corps of naval constructors and of civil engineers. The recommendations of the Department for the increase of our fleets is endorsed and the following shipbuilding programme outlined: Two battleships and two armored cruisers, all of the maximum displacement; six light draft gunboats and smaller vessels for river service, and the colliers, training ships, transport and repair ships recommended by the Board of Construction. The Report also suggests that the increases in the personnel in the case of the enlisted force of not less than five thousand men. The suggestion is also made to revive the office of Vice Admiral.

S.S. Saale.—The North German Lloyd steamship *Saale*, which was burned in the fire at the Hoboken docks of the company last summer, was recently put up for sale in New York by the owners. An upset price of $100,000 was fixed on the vessel and this prevented any bidding, as the junk merchants who attended were prepared to pay a price for scrap only, figuring that the vessel could be bought in for less than $20,000. It is reported that the vessel will be patched up and sent abroad for a complete overhaul.

TORPEDO CRAFT (UNITED STATES AND FOREIGN) TYPES AND EMPLOYMENT.—IV.*

BY LIEUT. R. H. JACKSON, U. S. N.

Below Deck.—Below decks, the floors in the living spaces should be of hard wood. In the cabin compartment a covering of thin linoleum tacked down on some light wood, as soft pine, works well; when given a coat of shellac once or twice a month, this gives a durable floor, easily kept clean and dry in all weathers. In the crew's quarters a coat of shellac each week, applied to the bare hard wood, gives the best result. All this wood should be soaked in paraffine or electroproofed to prevent absorption of moisture from the bilge and swelling, so as to make constant misfits of the movable hatches. As electroproofed wood is said to cause corrosion of steel, the edges of the floor that come in contact with hull should be oiled or painted to prevent such a result.

More permanent discomfort has existed on board the boats from a failure to give a thin canvas lining to all living spaces than from any other cause.

In the *Cushing*, which in her early days boasted four officers in her cabins, icicles hung from the "roof" in the morning, and rheumatism was common. To remedy this an inner lining of canvas was fitted, leaving an air space the depth of the frame between it and the deck. This probably reduced the sweating, and any moisture that was precipitated ran down the side behind the inner lining and then into the bilge. On some boats where this lining was fitted, the outboard side of the men's lockers being the skin of the ship, the streams trickled into their lockers, with the result of wet clothes and more rheumatism.

On the vessels of the *Winslow* type the men had to sleep under rubber blankets until linings could be fitted. Very thin boards have been used at the side instead of canvas, but this raised the objection of splinters from a shell. The canvas is neat, light, and durable.

While on the subject of inner lining, it is well to say that this offers additional hiding place for the pest often brought off in wash clothes; but it has been found that the use of Persian insect powder every two or three weeks, closing up the compartment tight for an hour while the powder was being sprayed, was not only a prevention, but a cure for all crawling creatures.

Living Space Steam Heat.—Here again has experience done much toward securing a system and arrangement that have added greatly to the comfort on board the boats. The most remarkable arrangement was a case where the radiator in the cabin was placed at the highest point of the bulkhead. This would give in cold weather a temperature of 90 degrees at the overhead deck and 30 degrees on the floor. If there was any ventilation at all the occupant always enjoyed the temperature of the outside air, even though it was 20 degrees.

By the simple arrangement of carrying a 1 1-2 in. pipe along the floor close to the lockers, the ventilation and heating are easily arranged. This position

*Prize essay read before the U. S. Naval Institute, Annapolis, Md., and copyright, 1900, by R. H. Jackson, U. S. Naval Institute.

of the pipes also assists in keeping the lockers dry. It is well to always have at least one more steam pipe parallel to the first, extending a part or all the length of the other, with a valve at each end; by this means additional heating surface can be thrown in for severe weather. On the *Cushing*, by this arrangement, from one to four pipes could be used as desired; after they were installed she was always comfortable. A radiator is a source of discomfort. It is like a redhot stove in a small dining-room. The one who sits next to the stove roasts, and those further away freeze. The crews, on account of the size of compartment, are always at the table.

In connection with the steam-heater pipes there must always be an efficient steam trap intelligently tended. Ignorance on the part of the men on watch in the engine room is often a cause of cold steam pipes banked up with water.

Sinks, Basins and Closets.—The closets are, generally speaking, as satisfactory as under-water closets can be. Occasional trouble is experienced from ignorance in the use of the valves and carelessness in throwing waste and similar objects in the bowls. A good, safe practice, however, has been to shut off the sea valves when under way for many hours, if the weather be rough, and not depend on the interior valves for controlling the water. When the closet is used the valves can be opened temporarily, and again closed. The use of proper closet paper is a necessity if the closets are to be kept in order.

The pantry and other sinks should all be fitted with an automatic valve, such as rubber ball, etc., to keep the pipe closed from the sea, opening only by pressure of water from the basin; otherwise the water will boil up into the basin when at sea, and a precious pint of fresh water be converted into salt by the lifting of the stopper in the basin. In the *Winslow* type, when at sea, it was always necessary to put permanent plugs in the bottom and overflow pipes, and then bail out the water after using, making it much more inconvenient than a tin basin and pitcher would have been. Needless to say, the automatic valve should be easily accessible, to examine and take out the stray articles that are sure to find their way into the pipe and stop it up. Especially does this apply to valves for the closets.

Living Quarters. Position.—The arrangement generally adopted for officers, and if there is space, petty officers, forward, meets with best results. The place of the officers, especially if there is but one, is by the wheel, which can only be attained by placing his cabin near it. As the steering is all done from the forward tower, this reason alone is sufficient for the officers' quarters remaining forward. As to the comfort, it is in many cases an open question, as the heat from the steering engine and fire-room is often intense, the ventilation in a rough sea is almost nil, and the quarters are often drowned out. The advantages are, ordinarily, less cinders and dirt, and less vibration, though these conditions are not always true. It is important if possible to have the chief petty officers separated from the crew.

Tables.—The solid table, that is, one with the sides closed in so that it is stowed completely with crockery, tableware, warheads, etc., is most satisfactory, being fitted with a leaf on one or both sides to permit a free gangway. Swinging and folding tables have been tried on several boats and have always proved unsatisfactory. They are troublesome to set up, unsatisfactory to eat on, and bulky to stow away; moreover a table is in constant use all day long, and is a great convenience as a temporary receptable for charts, books, bundles, writing desk and a thousand other purposes at all times. I recently noticed that the crew of a certain torpedo-boat took all their meals squatting round on deck; upon going below I found that the boat had been fitted with a swinging table that was stowed away in a corner and never used.

Chairs and Stools.—The best and most efficient are the simplest camp-stools of light design without backs and seats covered with canvas. These can be scrubbed and kept white, or given a coat of shellac or paint as is most practicable. About the best chair for comfort, compactness and durability is the cheap steamer chair made of two cross pieces on a side, holding in varying positions a strip of canvas.

Ice Chests.—Many have been the makeshifts for this exceedingly essential fitting, which seems to be an afterthought. Starting with the *Cushing*, which utilized a hard-tack can, and continuing to the *Winslow*, which had a wooden box perched on the rail, exposed to the hottest rays of the sun and the all-penetrating salt spray, the best result has been obtained in the *Talbot* class, where a compact, light and serviceable ice-chest is built to the shape of the boat alongside the pantry. The additional supply of fresh food that can be carried with a properly equipped ice-chest adds materially to comfort, and the reduction in the mess bill is also considerable.

Bunks.—The system of bunks for the crew, two tiers, sleeping car fashion, with pipe frame and laced canvas bottom, are excellent, being light, clean and dry.

The upper berth system of the Pullman car seems on the whole to combine the greatest number of good features for the officers' quarters. This is a transom that folds against the ship's side when closed, and when made up swings out about 30 degrees, being held out by straps below. The bunk bottom, a canvas sheet, is fastened along the upper side of this transom, and is held dry out taut, and the mattress laid on this. It is comfortable and dry, because, except when in use at night, it can be closed up tight. Whereas a bunk that stands open may catch the unexpected sea or rain squall; and a wet bunk—there is nothing worse!

Officers' Quarters.—There has been a great variety in the arrangement of bulkheads, pantries, closets, etc., in the space allowed for officers' quarters, the idea most prominent apparently being to give each officer a room to himself. The result is a series of little cuddy holes, no one of which is habitable; whereas the same space with only one or two divisions would give quarters easily ventilated, reasonably cool and dry.

Taking the worst results first, there is on the *Winslow* ample space provided for living quarters; but analyzing it in detail there is not a comfortable spot in her. The captain's state-room, a separate com-

partment farthest forward, has a fixed bunk placed under two or three small ventilators, that will usually either sweat or leak on his bunk according to circumstances. The next compartment, the mess-room, has two transom bunks which are so low that the spray that comes in from the hatch overhead means no ventilation, or a wet bunk, if the sea is at all rough. The closet is next in a small compartment by itself. Abaft this on the port side a fixed bunk, with standing room alongside it; there is not room to sit down and undress, this being done by sitting on the bunk. On the opposite side, in another compartment, two wash basins, fixed, for one officer; abaft this in another compartment, the pantry. In passing, it may be remarked that the food was always hot, as the pantry was very small, and, separated from the fire-room by a thin bulkhead, it served as a satisfactory oven to every one except the occupant, the steward. A space amidship between the pantry and washroom on one side and the state-room on the other was useful only in admitting the ladder which occupied nearly as much space as the state-room alongside of it.

A great improvement could be made in this arrangement with but little expense. Considering the entire space abaft the mess-room, all partitions should be removed, and the arrangement of the floor space be as follows: On the starboard side aft, the closet and one wash-basin should be placed, the latter some compact type, instead of the enormous aluminum one now in use. This compartment could be cut off by curtains or low partitions from the remainder of the space. If partitions are used they should only be about 7 ft. high, the angle irons running up to the deck overhead to prevent vibration. The remainder of the space would make a comfortable room. Below the hatch a vertical ladder would be secured to allow passage when necessary, but the main gangway would be through the conning tower. The hatch in the conning tower should be larger, and more convenient ladders fitted.

The simplest and most satisfactory arrangement for officers' quarters would seem to be two compartments, one for each officer. The junior officer's room would contain two Pullman upper berths, placed well up on the side with a transom seat below each. This would also be the mess-room. The pantry would be placed as convenient, near or in this compartment. The senior officer's room would be the next compartment, preferably abaft this, with the bath-room containing the closet and basin, and usually a fixed bath-tub, set off in a corner by a low partition and curtain.

The old idea of giving the captain complete seclusion from his officers, when carried out in a torpedo-boat, is absurd; and he often has roasted or steamed in his effort to get rest in his own cabin; or else occupied his junior's bunk until time to go on deck and relieve him for a six-hour watch.

Of the two compartments contemplated, the captain should have the more comfortable one, and it might vary in the different boats. But in one should be the mess-table and in the other the baths, basin, etc., cut off by a low partition; the pantry being worked into the one or the other as the plan permitted. If these two compartments are separated by a low bulkhead amidships which could go all the way to the overhead deck toward the sides, ventilation through the hatch in the after one and the conning tower in the forward one would ordinarily be good. In general each conning tower should admit to two compartments; that is, it should be supported on the water-tight bulkhead with ladders down each side of the bulkhead. In case the compartment on the side forward of this bulkhead is a living compartment, e. g., the mess-room, there should be a hatch with a reversible square ventilator hood, water-tight, fitted over it. This could face to leeward at sea except in exceedingly rough weather, when it would have to be closed.

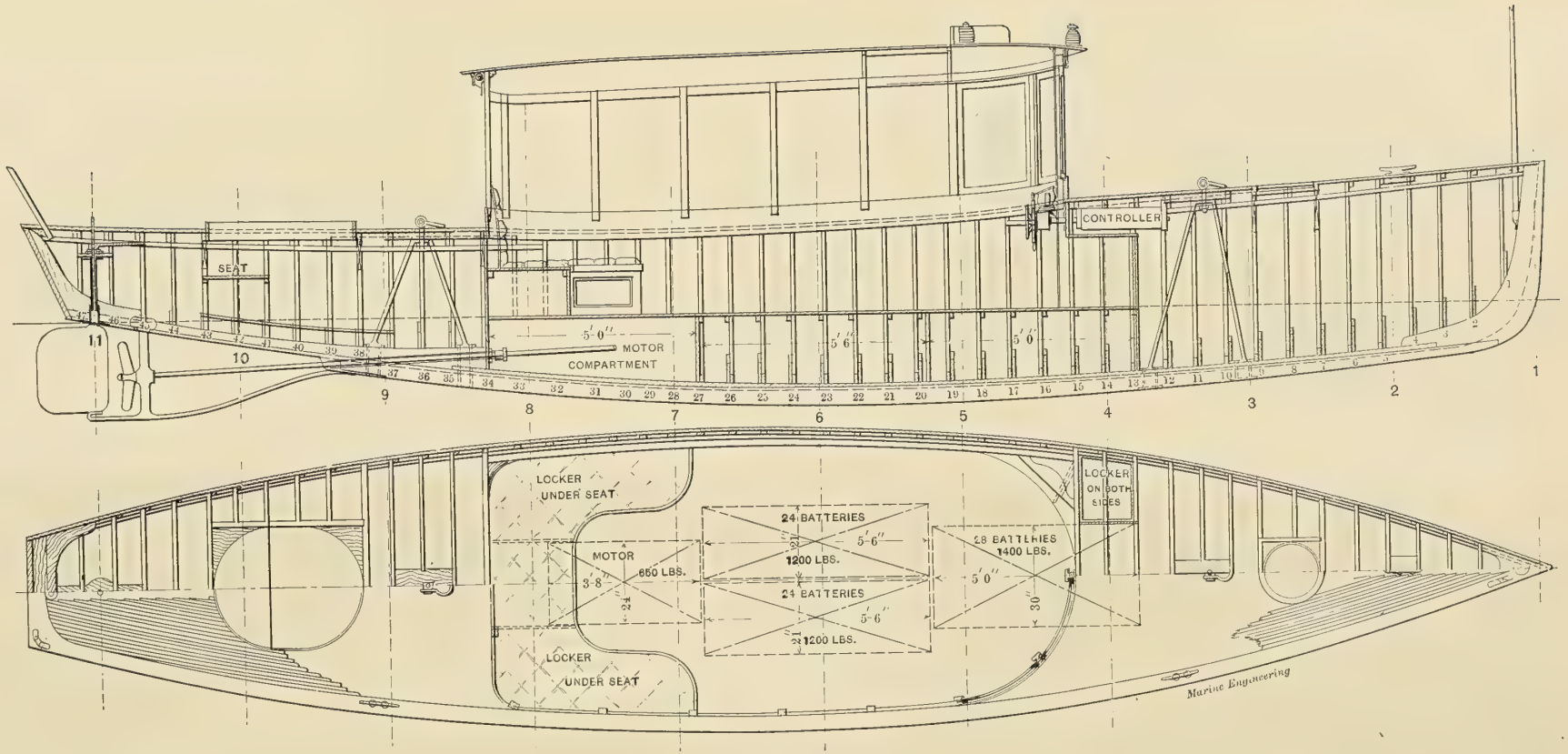
Boats of less than 100 tons should have but one large compartment, with an addition for pantry, closet, etc.

A Bullock Electric Launch.

A handsome electric pleasure launch in service on Long Island Sound is shown in the accompanying plans. This boat is the property of George Bullock, of the Bullock Electric Mfg. Co., and is, of course, representative of the most up-to-date practice in electric propulsion for small pleasure craft. The launch was designed by Gardner & Cox, of New York, and is of these dimensions: Length over all 37 ft.; on water line, 35 ft.; beam, 7 ft. 3 in.; depth, 4 ft.; draft, 2 ft. 4 in.; carrying capacity, about 10 or 12 persons.

The boat has three water-tight compartments, the two end compartments having sufficient buoyancy to float the boat in case the center compartment should become filled. Amidships there is an enclosed cabin 14 ft. long, fitted with drop windows. At the after end of the cabin there is a divan seat with lockers underneath, and there are movable chairs forward of this. The forward end of the house is rounded and here is located the controller, the steering wheel and compass. Aft of the cabin there is a small cockpit with seat. Lifting eyes are provided, as shown on the plan, so that the launch can be used as a yacht tender, or hoisted out of the water in the winter season. In form the boat is cut away aft giving her a flat stern, and she is fitted with a skag which carries a strut just forward of the wheel, and through which the shaft passes. Oak is the material used for the construction of the keel, frame, stem and stern post, and the planking is in two thicknesses, the inner plank of cedar and the outer of mahogany. All the frames are steam bent. Mahogany is also used for the deck and covering board and for the cabin finish.

In a water-tight well which reaches nearly to the cabin floor the motor is carried, and the storage batteries are placed as shown in the plan of the boat and in detail in the plan on page 17. The wiring plan on page 18 shows the system of wiring used by Mr. Bullock in his residence, and the connections to the boat house and to the battery on board the launch. The generating plant, which is located in the residence, consists of a 15 horse power Nash internal combustion engine direct coupled to a 9 k. w. generator. The lighting of the house is controlled from a panel shown in the wiring plan placed at a convenient point upstairs in the house. The connection



PLANS OF THE 35 FOOT ELECTRIC LAUNCH DESIGNED BY GARDNER AND COX FOR GEORGE BULLOCK IN SERVICE ON LONG ISLAND SOUND.

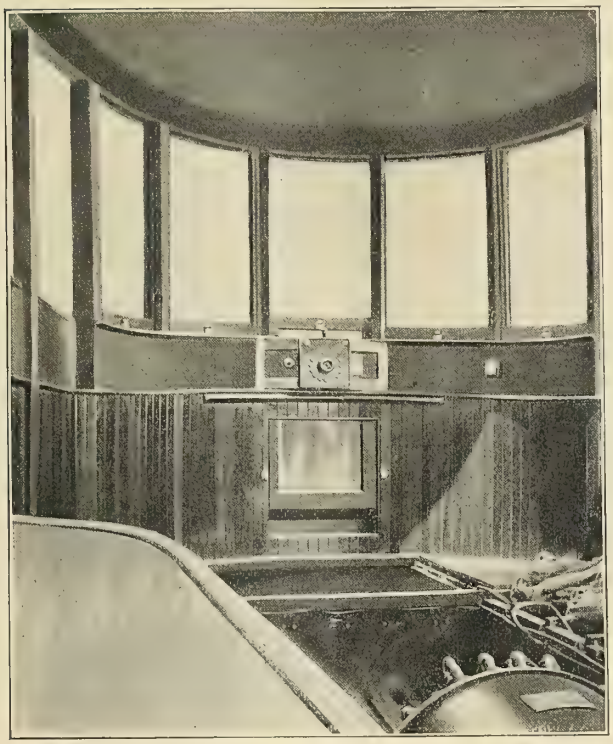
between the shore plant and the boat is made at the boat house by flexible cables with plug ends which can be readily connected when it is necessary to charge the storage batteries.

In the launch the Gould storage battery is installed, there being eighty cells, each cell made up of 15 plates. The normal charging rate per cell is 63 amperes, and the battery is rated as being capable of furnishing 52 1-2 amperes for a period of four hours. In practice, however, the boat has been driven 40 miles at a speed of 8 1-2 miles per hour, and a discharge rate of 68 amperes. The weight per cell is 60 lb. and the weight of the electrical equipment, including motor, controller, switchboard and wire is 6,000 lb. The total weight of the launch is approximately 8,500 lb.

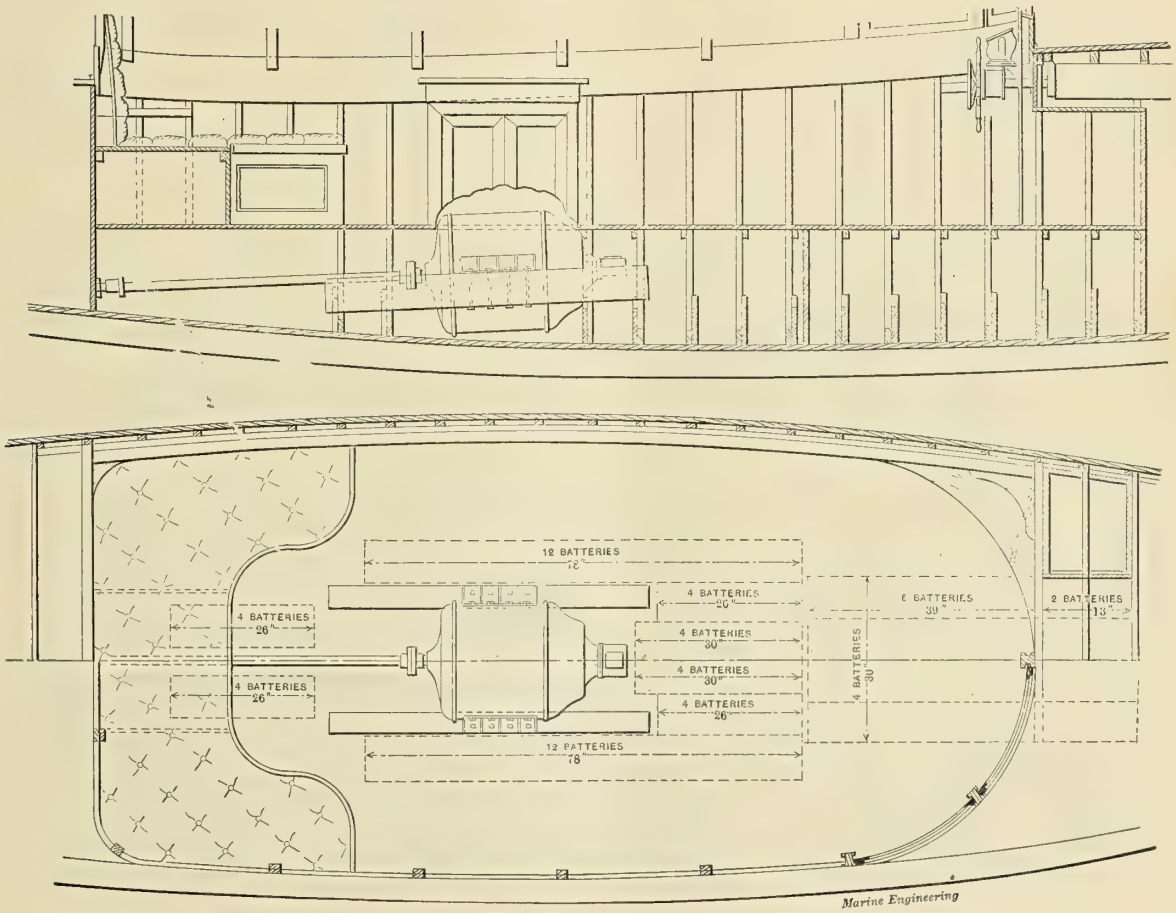
A direct current multipolar Bullock motor is employed. This is rated at 7 1-2 horse power, with 90 volts pressure, but will develop 15 horse power for short intervals. The boat controller provides for three speeds as follows:

1st speed	40	volts and	46	amperes	5	miles per hour.
2d	"	80	"	"	68	"	8½	"	"	"
3d	"	150	"	"	100	"	11	"	"	"

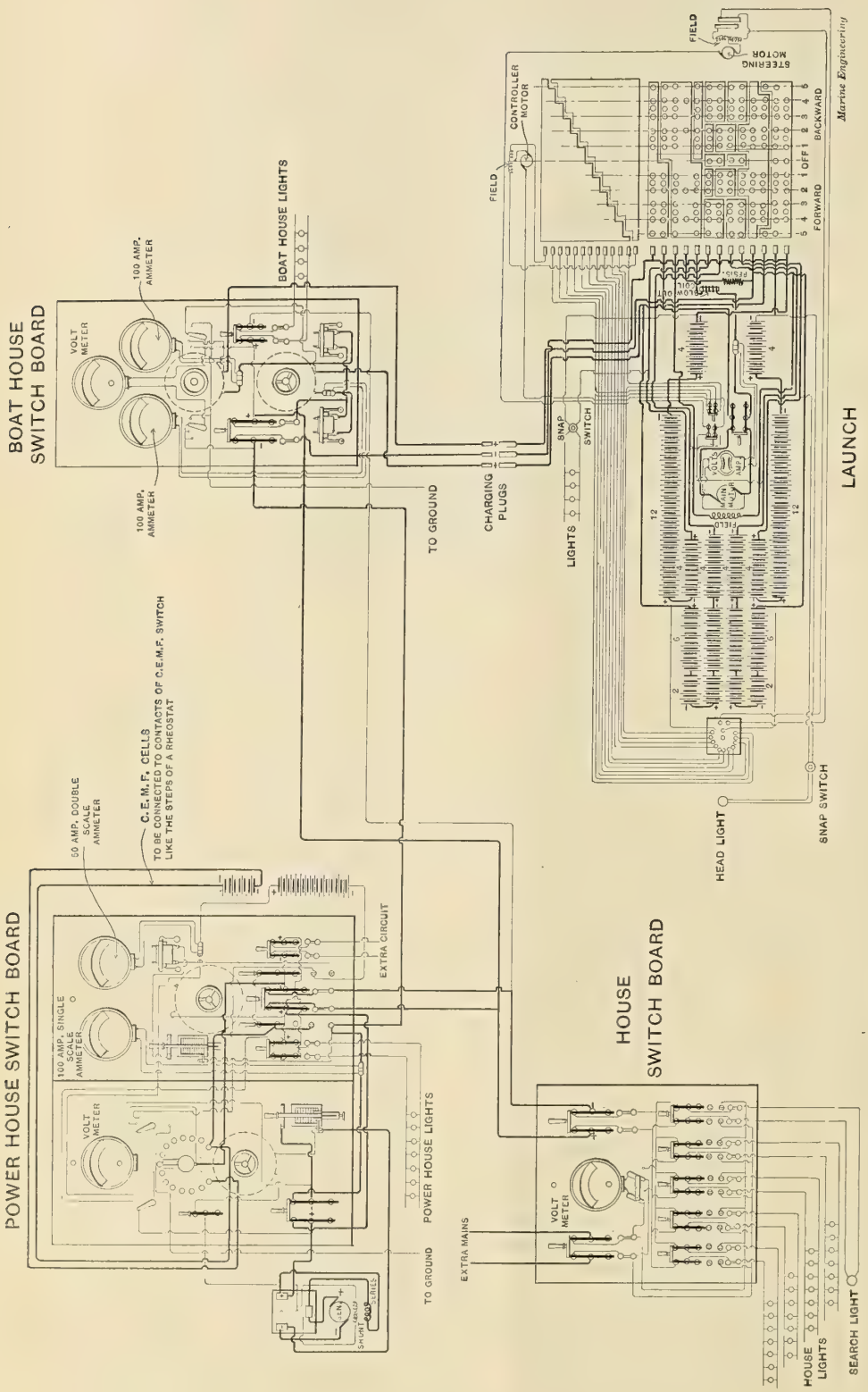
The motor is of the enclosed type, with field of a circular yoke of special steel. Pole pieces are built



INTERIOR VIEW OF FORWARD END OF CABIN.



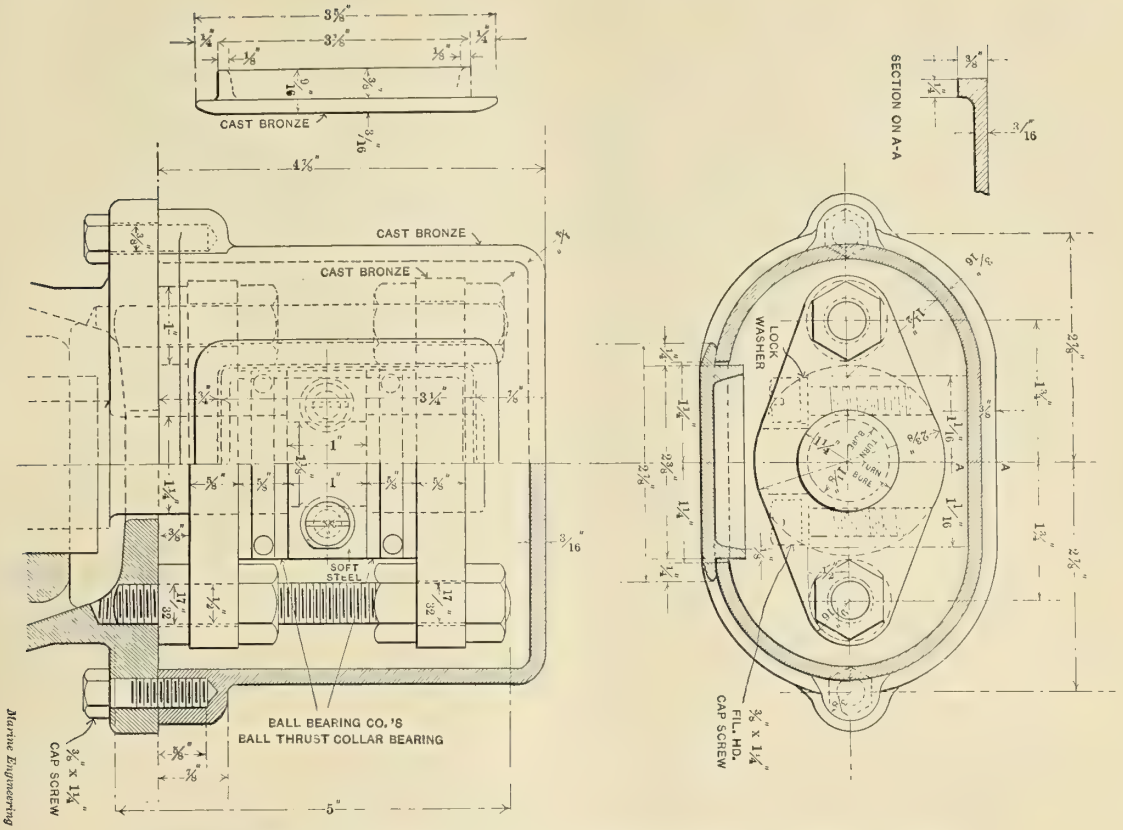
DISPOSITION OF MOTOR AND BATTERIES IN ELECTRIC LAUNCH OF GEORGE BULLOCK.



WIRING PLAN OF RESIDENCE, BOAT HOUSE AND ELECTRIC LAUNCH OF GEORGE BULLOCK ON LONG ISLAND SOUND.

up from soft sheet steel securely bolted to the yoke, the shape of the punchings being such as to produce a saturated pole face. The field coils are machine wound and are slipped over the pole before it is bolted to the yoke. Thin carefully annealed sheet steel elements are used to build up the armature core, and this possesses a high magnetic permeability. Drop forged pure lake copper with mica insulation is used for the commutator, and the brush holder is of the reaction type. When once the brushes are set no further adjustment is necessary, as the motor will go ahead or reverse without sparking at all speeds of the controller.

Thorough tests of the boat under varying conditions of wind and water show that she is a good



DETAILS OF BALL THRUST COLLAR BEARING IN ELECTRIC LAUNCH FOR GEORGE BULLOCK.

sea boat and is speedy when occasion requires. A continuous run of 40 miles did not exhaust the storage battery. In addition to supplying current for the propulsion of the launch, the batteries take care of the running and cabin lights. When the battery is exhausted it requires about four hours for recharging. All the details of the launch have been very carefully worked out, and as an interesting example we reproduce a drawing of the thrust block which is fitted with Ball Bearing Co.'s ball thrust collar.

INSTANTANEOUS PHOTOGRAPH OF ELECTRIC LAUNCH MOVING AT TOP SPEED.

THE FLOATING DOCK AS AN ADJUNCT TO A WAR NAVY.—I*

BY LYONEL CLARK, M.I.N.A.

A very characteristic development of a war navy of the present time is not only the great increase in the size of the vessels of which it is composed, but more especially the great diversity in the dimensions of these units, owing to the prevailing custom of including therein the largest of the ocean liners as auxiliary cruisers.

This development has naturally brought in its train a similar development in the size of the dry docks, which have always been a necessary adjunct to any fleet. Indeed, with a modern fleet, the dry dock is of greater necessity than ever, for, not only does the material of which ships are now built more rapidly suffer from want of inspection and protective covering, but their speed—so important a factor in the fighting value of a fleet—will rapidly deteriorate unless their bottoms are frequently cleaned.

Up to the present time the more generally adopted method of getting at the under water portion of a ship has been the masonry graving or sunk dock.

This is essentially a containing vessel, and as such its dimensions must be, in every direction, in excess of those of the ship it is destined to accommodate. An examination of a list of the different vessels that compose a modern navy will show how diversified are the dimensions of its units. Taking the question of length, although the generality of the line-of-battle ships do not attain 500 ft. 0 in, yet the same fleet which possesses these vessels may also include auxiliary cruisers whose length will exceed 700 ft. 0 in. The beam, whilst about 75 ft. 0 in. may be taken as a normal figure, still vessels are found of a width of over 78 ft. 0 in. In draught, while somewhere about 28 ft. 0 in. appears to be the usual figure for ironclads in fighting trim, there are cases where this is increased to over 31 ft. 0 in. The type vessel of the present day, therefore, that the engineer has to consider when designing his dock is one of a length of over 700 ft. 0 in., a beam of over 78 ft. 0 in., and a draught of over 31 ft. 0 in.

The dock itself, however, seeing that it has to contain such ships, must have still larger dimensions. In length, owing to the shaped ends of a modern ship, no great clearance is needed, but at the same time there is nothing to show that 700 ft. 0 in. is the length record that will remain unbroken even for the time it would take to build a graving dock, and the engineer who designed one with a less length than 750 ft. 0 in. would show but little foresight.

In beam the dimensions of existing basins and entrances would fairly seem to promise that but little increase is to be looked for in this direction, still a good deal of clearance is required for a dock if it is intended that any work is to be done on the ship placed in it.

It may be said that 5 ft. 0 in. each side would be the least practical working room, but bearing in mind the advantages of the free circulation of air and light round the vessel, it is not surprising that 10 ft. 0 in. is more usually allowed, so that in an ideal dock the width of the same should not be less than 100 ft. 0 in.

It is true that the entrance itself may be of less width than this, but nevertheless in the body of the dock itself this width is not only required at the coping, but, owing to the square bilges and the projecting bilge keels of the modern vessel, it must be carried right down to the sill or even floor of the dock. It is no longer sufficient, as in the days of vessels with sharp rise of floors, to build a narrow invert with well battered sides, or it may be found—as indeed has been the case in America—that many even recently built graving docks, although fully wide enough at the water level, are quite unable to take in the modern ironclads on account of their bilge keels fouling the altars.

The question of depth of water over the cill or keel-blocks is of still greater importance. It is not sufficient in a naval dock to allow the ship a nominal clearance under normal conditions; the docking of vessels in a more or less damaged state must be looked for, especially in times of war, and considerable provision should be made for increased draught. There seems to be a generally accepted idea that an addition above the fighting draught of about 5 ft. 6 in. represents the limit at which an ironclad could float and still retain stability, but unless such clearance be combined with a wide entrance of dock it is doubtful whether even this depth is sufficient.

In a paper which the author had the privilege of reading before the Naval Architects in 1896, he drew attention to a fact since emphasized by Laird Clowes in an article in the *Fortnightly Review* of May, 1897, namely, the possible difficulty of getting a damaged vessel of large size into even a modern stone dock. It was pointed out that if such a vessel were down by the head as little as 3 ft. 6 in., this, combined with a list of 5 deg., would make her bilge keels foul the entrance even of the largest and most modern docks then existent.

The position of the sill does not, however, give the complete depth required for the dock. A modern flat-bottomed vessel requires to be placed on keel-blocks at least 4 ft. 0 in. high if work is to be freely carried on under her bilges; added to this, in tidal ports at least, a further allowance should be made in order that a vessel may be docked at all states of the tide. This is a point which has not yet—or at least not in the case of graving docks—obtained the attention it deserves. It is too commonly the practice to be content with docking vessels only at high water, and even in some cases only at the top of spring tides. War is no respecter of persons or machines, and, apart from the great advantage that must always obtain in being able to at once dock a war vessel and put the repairs in hand at any time, there is, in addition, the danger that a prolonged wait for a suitable tide may, when one considers the possible state of a vessel after a severe fight, make it doubtful whether it could remain afloat until the tide suited.

Rise and fall of tide is naturally a varying quantity in different localities, but it may be asserted that a dock that could not accommodate a lame duck from half flood to half ebb, at the very least, could not be said to properly fulfill its requirements.

*A paper read before the International Congress of Naval Architecture, Paris Exposition, Paris, 1900.

In the case of English docks this would mean that their normal 33 ft. 0 in. of water over the blocks at ordinary high springs should be increased to about 43 ft. 0 in.

We are now in a position to see what should be the size of a modern naval dock. It should have a length of 750 ft. 0 in., a beam of 100 ft. 0 in., and a depth over the bottom of 47 ft. 0 in. It is hardly necessary to point out that to construct such a dock with an invert 10 ft. 0 in. wide and nearly 50 ft. 0 in below water level would be a serious undertaking. The thickness of the invert of the Portsmouth docks which have only 33 ft. 0 in. of water over the sill is about 15 ft. 0 in., so that there would be a hydrostatic pressure over the whole of this broad invert of about 30 lb. per sq. in. It is not, therefore, surprising to find that existing docks have been chiefly constructed to take vessels only at high water, and one can understand why so many of them had the narrow invert and great batter of side walls which rendered them, although when viewed from above appearing everything desirable, quite useless for modern vessels.

To construct an ideal dock as above described even in good soil would be a task that the engineer would approach with caution, whilst in made land its construction, if not impossible, would certainly be impracticable.

But whilst the art of shipbuilding has been making the remarkable progress so strongly characteristic of the present age, other kindred industries, in accordance with that great law of nature which seems to ordain that progress shall go forward equally, have been advancing, using for their ends the same knowledge, the same productions, and the same tools.

Amongst others, one structure which has kept its place closely in line with the modern development of shipbuilding is the floating dock.

The author's firm, Clark and Standfield, have, for a period that now nearly approaches the half century, made a specialty of these structures and have seen them develop from the small timber and iron pontoon up to the large steel floating docks of the present day with an area of nearly an acre and a half, and capable of dealing with the largest vessel at present built or building, and what is perhaps more satisfactory for them is that they have seen the gradual growth in the number of docks under construction from a very modest beginning until the present time when they have in their offices the plans of docks now being built whose aggregate lifting power nearly totals up to 50,000 tons.

The better the floating dock is known and examined, the greater will appear its advantages. It has its limitations, of course, but so has every other construction, and the best dock is the best compromise between such limitations. There is, perhaps, an inclination to look on a floating dock with a large ship on it as a somewhat unstable combination, and in the past some of the older docks certainly did suffer from this defect. But this was rather due to want of knowledge than to any fault in the principle of the dock, and it is evidently as easy a thing to endow a dock with any desired amount of stability as it is to perform the same operation for a battleship.

Floating docks have also been frequently accused of want of stiffness or rigidity. Whilst the author cannot refrain from remarking that if there is any structure in the world that should not require a rigid bed, it is a ship that passes its whole existence in the very unstable medium of the sea, and that such is practically the case is fully demonstrated by the successful use of the sectional docks in America, still, there are conditions, and especially so in the case of a war navy, in which such diversified types of vessels exist, where great longitudinal stiffness becomes necessary. This is a subject to which the author's firm have given the greatest attention, and the type of dock which they have but lately introduced, especially with a view to meeting this difficulty, will, it is believed, entirely overcome the same. Here, again, one can only say that if the naval architect can construct vessels over 700 ft. 0 in. long that are hurled through the Atlantic gales at railway speed, surely the same men with the same knowledge and the same materials at their disposal can design a structure safe enough to carry such vessels, when it is remembered that it has only to float in the smoothest of waters.

That the latest type of dock has ample stiffness is shown by the fact that two of them have already been successfully towed, one across the Atlantic Ocean and the other across the North Sea, whilst of two more under construction, one will again have to cross the Atlantic and the other to coast round the best part of the eastern shore of North America.

Another unfounded belief is that the steel floating dock is short-lived, but here again modern advance has not been reckoned with. There are hardly any floating docks built now-a-days that are not entirely self-docking, that is to say, that permit of the easy visitation of all their parts both inside and out. With proper care, therefore, there is no more reason why a steel dock should deteriorate than there is that our roofs and bridges and similar structures should do so. Experience is not yet long enough to know the complete duration of iron structures, but fifty years certainly does not practically deteriorate them, and half-a-century should be almost long enough to look forward to. Indeed, too much account may very easily be placed on the advantage of a long-lived structure. The world does not stand still, and the requirements of to-day are not those of the morrow. One cannot help making the pertinent remark that the stone docks of the last century, although still in excellent preservation, are not of any very great use now-a-days; and it would not be unfair to prophesy the same of our present docks fifty years hence. It is not well for progress that humans should look too far ahead.

Coming now to the advantages of the floating system, and beginning with the selection of the site, the floating dock will give a wider range of choice in that not only is the whole of the water space available, but even dry land can be utilized. The excavation required for a floating dock will not exceed in size and depth that required for a masonry dock, with the great advantage in favor of the former that such excavation can be carried out by means of or-

dinary dredging or grabbing, and requires no cofferdams or pumping to keep the dredged hole free from water for the putting in of the invert.

There is also an advantage in the rapidity with which work on a floating dock can be commenced; there is no necessity for careful borings in order to determine the nature of the site before the drawings can be commenced; within a few days of the determination to proceed with the work, the first drawings and quantities can be got out and the steel hull commenced; and whilst this is completing, the site can be dredged out; the two operations proceeding simultaneously instead of having to wait one on the other as in the case of the masonry dock. Indeed, the rapidity with which a floating dock can be constructed is very remarkable and the author will doubtless be allowed to cite the case of the Stettin dock as a proof of this assertion. This dock, of a lifting power of 11,000 tons, had the first plates of the bottom laid on the blocks 23 days after the first intimation of such a dock being required was brought to the author's firm. The dock was completed and launched within 7 1-2 months from such date. During this time the hole for its reception had been dredged in the river bank, and within 8 months and 13 days from the first inception of the project, the dock after having been towed to its site and moored in place, was lowered ready to receive a vessel.

Similar rapid construction was effected in the case of the 10,000 ton dock for the Spanish Government at Havana, and here, perhaps greater credit still is due to the builders, who were the same in both cases, namely, C. S. Swan & Hunter, of Wallsend-on-Tyne, for they were considerably handicapped by not obtaining possession of the yard where the dock was to be built until some time after their contract was signed, but still the dock was delivered at Havana, 6,500 miles distant, within the contract time of eleven months.

In the commencement of this paper it was pointed out that the dimensions of a graving dock had to be larger than those of the ships in every direction. Such dimensions form, therefore, absolute limitations to the usefulness of the dock, and should the ship exceed any of them to the smallest extent, this would be sufficient to absolutely bar the usefulness of that dock for that ship.

A floating dock is not, however, so limited. Being open at each end it can take ships of any length.

It is not a question of the dock, but rather whether the ship is strong enough to support its overhanging portions projecting beyond the same. In a stiff girder-like structure like a ship, the permissible overhang experience has grown to be very large, and indeed in modern ships the tendency of builders is to take advantage of this. In order to obtain maneuvering power, it is the common practice to considerably cut away the deadwood aft and carry the forefoot a long way back into the keel. In warships this is most marked, and the author has got together in a table a few typical examples of such cases.

Doubtless, in many of the extreme cases shown by some of the war vessels, it is intended to support them when docking under the raised portion of the keel as well, and, indeed, the author is aware that such is the intention in some cases; but for the liners no such support would be necessary, and it is interesting to note that a floating dock of a length over keelblocks or lifting portion proper of only 560 ft. 0 in. would provide all the bearing surface asked for by the builders, for the longest vessel at present afloat. Light lattice projections at each end would doubtless be useful beyond this length to provide working platforms, but this is a very small matter, and separate rafts might equally as well be used.

The above facts form an interesting comparison between the length limitations of graving and floating docks, for whilst the minimum length of the former for such vessels as the *Oceanic* would be 706 ft. 0 in., the maximum length of dock proper required in the case of the latter would be only 560 ft. 0 in.

The beam of a floating dock is of course limited by the position of the side walls. On the other hand, however, there is but little constructional advantage in keeping the invert of small width; there are no gates to be closed against a heavy water pressure, nor anything else to induce the engineer, unconsciously perhaps, to keep his entrance as small as possible. In the same way there is no need of heavy side walls with a large amount of batter to compensate for the water pressure on the invert, but the docks can, if desired, be built with vertical walls, and present a square profile right down to the floor.

Again in the question of draught of water over sill, the limitation, which is absolute in the case of a graving dock, is only partial in that of a floating dock, for this, although normally constructed for a given draught, could always be lowered a foot or more deeper, if the dock-master saw that by so doing he could accommodate a special and urgent case.

The necessity of dealing with vessels at all states of tide, a point already raised, also disappears in the case of a floating dock. No vessel will have to be refused because the tide that day has not come up high enough over the sill. A floating dock can work as well at the top of spring tides as at the bottom of the same. No alteration or modification is required to the dock itself, it being merely a matter of dredging the hole for its reception a little deeper.

The floating dock has, however, its limitation, and that is in its lifting capacity. If the ship displaces more than the dock's buoyancy, it cannot be lifted. But here again the limitation is only partial. A ship either can or cannot get into a graving dock—there is no halfway house—but the floating dock, although it may not be able to lift a ship completely, can always do something towards it. There is no commoner accident to the ordinary ship than damage to the propeller, and to lift such a ship sufficiently high to get the stern tube out of water requires no very great buoyancy on the part of the dock, and many cases could be instanced where a dock has been able to thus successfully deal with vessels of nearly twice its normal capacity.

The mention of the question of the lifting power forms an opportune occasion for pointing out how very much less power is required by a floating dock to lift a given vessel in a given time.

When docking a ship in a graving dock, the whole of the contents, less only the volume of the ship, have to be removed by pumping. Therefore, the smaller the ship in dock the greater the amount of water to be removed, until, when it has to be emptied merely to prepare the berth for a ship, the whole amount has to be extracted. In the floating dock, on the contrary, the ship being supported by the buoyancy of the dock, the weight of water to be removed is only proportional to the weight of that ship, plus an amount representing the weight of the dock itself, whilst, when the dock is lifted light to prepare the berth, only its own weight has to be dealt with.

The saving thus effected is very great, and is not only apparent in the reduced first cost of the pumping plant, but remains constant through the dock's career in the form of a reduced coal bill.

A good instance of what this saving in first cost can be is seen from a comparison of two docks now building, both for the same government, and both with the same duties to perform. The graving dock requires a pumping plant comprising 2,940 indicated horse-power, and in addition two separate drainage pumps, each 245 horse-power. The floating dock, on the other hand, has an aggregate indicated power of only 800 horse, no drainage pump being, of course, required.

But, in addition to these structural advantages, there are other facilities afforded by the floating dock which are entirely wanting in the graving dock. The chief of these is its mobility. In the same way that the dock can be constructed in the home dockyards and towed to its destination, so can it later on in its career be moved from port to port as the exigencies of the moment require.

This facility may be of great advantage, as the natural tendency is to place all arsenals up some river or creek at a considerable distance from the open sea, where ships may lie out of the fire of the enemies' guns. Such positions have, on the other hand, the disadvantage that, as a rule, the channel leading up to them is long and tortuous, and with no too great depth of water. Take the case of Chatham, for instance; after a sea fight off the mouth of the Thames it would be a most hazardous undertaking to take a crippled and leaking ship with tired-out crew and nearly spent coal supply up through the channel of the Medway. Apart from the difficulty of navigating the ship, and the chance of her foundering on the long journey, the still graver eventuality has to be faced that if she did sink she might block the narrow channel, locking up the ships then in that arsenal and effectively cutting it off from any others who might be wanting its aid.

Here the capability of the floating dock comes into play. In times of peace it might lie at Chatham or in Portsmouth, or any other protected arsenal, but in times of war it could be moved down to the mouth of the Thames, or into the Solent, ready to pick up any of the lame ducks straggling home. Its work would not so much lie in complete repairs as in merely stopping bad leaks, and generally patching up things and making the hull tight and in a fit state to navigate the home channels.

Such a dock, might, indeed, be likened to a military field hospital, which renders first aid to the wounded, binds up their wounds, and sends them back to the safety of the base hospitals, which, in this case, would be represented by the fully equipped and protected arsenal.

But the advantage of mobility may go even further than this. It is impossible for anyone who has read Captain Mahan's work "On the Influence of Sea Power upon History" not to be struck by the advantage of the possession by one side or the other of a naval base where they could refit and repair their vessels. The successes of the English fleets in the wars round about the beginning of the present century were indubitably largely due to the excellent naval bases they either already possessed or seized during those wars, enabling them to rapidly refit after a fight, and again take the sea.

In those days any sheltered port formed a base, for the crew alone could haul down their vessels and repair under-water damage. With modern vessels however, a more elaborate outfit is necessary, and a dry dock of some sort is a necessity. Here comes in the utility of the floating dock. Escorted by a powerful and specially constructed tug carrying all the necessary repairing tools and a stock of material, once the new base firmly seized, the dock could be rapidly installed there, and in a few hours convert an ordinary natural harbor into a fairly equipped arsenal.

It is tempting to speculate on what might have been the result of the sea fight off Santiago had the one side possessed an arsenal at this port or the other a floating dock that they could have installed close by in Guantanamo Bay. One has only to make the very likely assumption that by the aid of fog or of a heavy enough sea to nullify the accurate shooting of the blockaders, the invested fleet had managed to slip past the blockading ring and obtain a small start, and their total annihilation or partial escape must have depended almost entirely on the relative condition of the ships' bottoms, in other words on the possession by one or other of the belligerents of a suitable dock.

Following this war still further, and assuming that it had been necessary for the States to send a fleet to European waters, can it be denied that the seizure of one of the Spanish islands in Europe, and the installation there of a floating dock, would not have allowed the American battleships to keep the sea for much longer periods, and her cruisers to patrol the enemies' seaboard with speed undiminished by foul bottom?

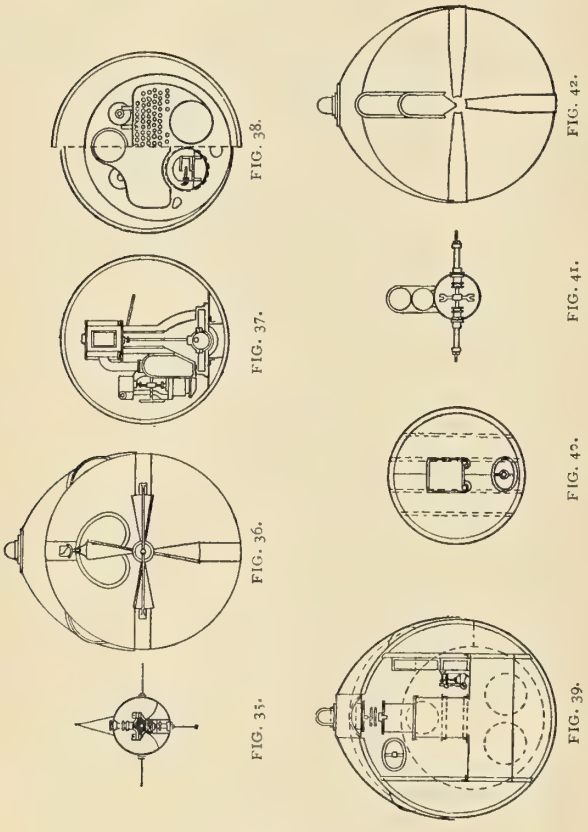
DIARY FOR 1901.—One of the most convenient diaries for those engaged in marine work is the Royal Navy List Diary and Naval Handbook for 1901, published by Witherby & Co., 326 High Holborn, W. C., London. This annual volume is a most convenient diary, having one page to each day, 6 by 9 in. in size, and in addition it contains a calendar and astronomical ephemeris for 1901, a review of the naval progress of the year in Britain, by G. C. Laughton; also comparative tables of British, United States and other war vessels, a record of meritorious service of British Naval officers, and a variety of similar information.

SUBMARINE BOATS — FROM THE EARLIEST RECORDS DOWN TO THE PRESENT.*—IV.

BY CARL BUSLEY.

CHAPTER XVI.

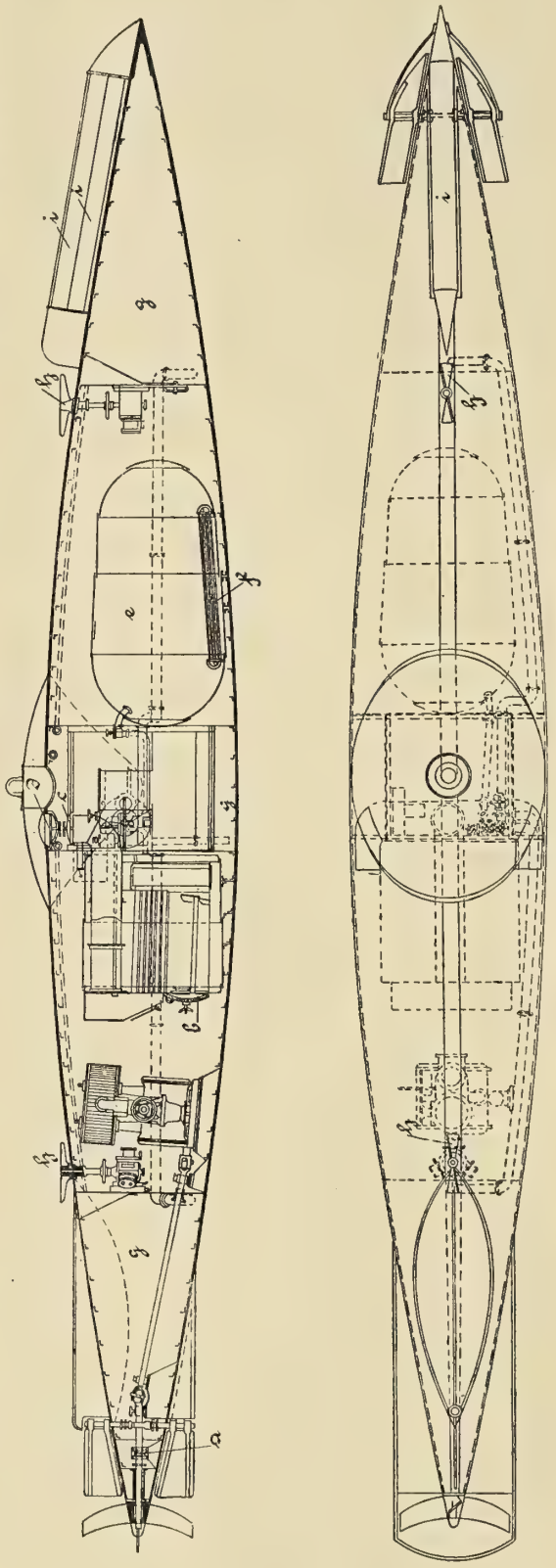
Nordenfelt's Boats for the Greek Navy, 1886.—Nordenfelt built two boats for the Greek Navy of the same pattern as that described in the previous chapter, and these were tried in the bay of Salamis, April, 1886. The press of Athens, of April 16, 1886, stated that the trials were unsatisfactory, as the boats could not remain submerged longer than two hours, and did not attain a speed much above two knots. One of the papers of April 17, 1886, which, no doubt, had been won over by the inventor, stated that the boats had realized the expectations, as they had attained a speed



of 8 1-2 knots. The latter figure, however, was the speed when sailing on the surface, and therefore does not contradict the statement of the papers of the day previous. It is an established fact that during the war between Turkey and Greece in 1897, neither the Greek nor Turkish navies ever entertained the idea for one minute of putting their Nordenfelt submarine boats into action, which seems to prove conclusively that they had no faith in them.

CHAPTER XVII.

Nordenfelt's Abd-ul-Hamid and Abd-ul-Medschid, 1887.—In January, 1887, Nordenfelt delivered two submarine boats to Turkey. They were built by the Barrow Shipbuilding Co., and were 100 ft. long, 12 ft. beam, and had a displacement of about 160 tons—(Figs. 33 to 42). The propeller is driven by a two cyl-



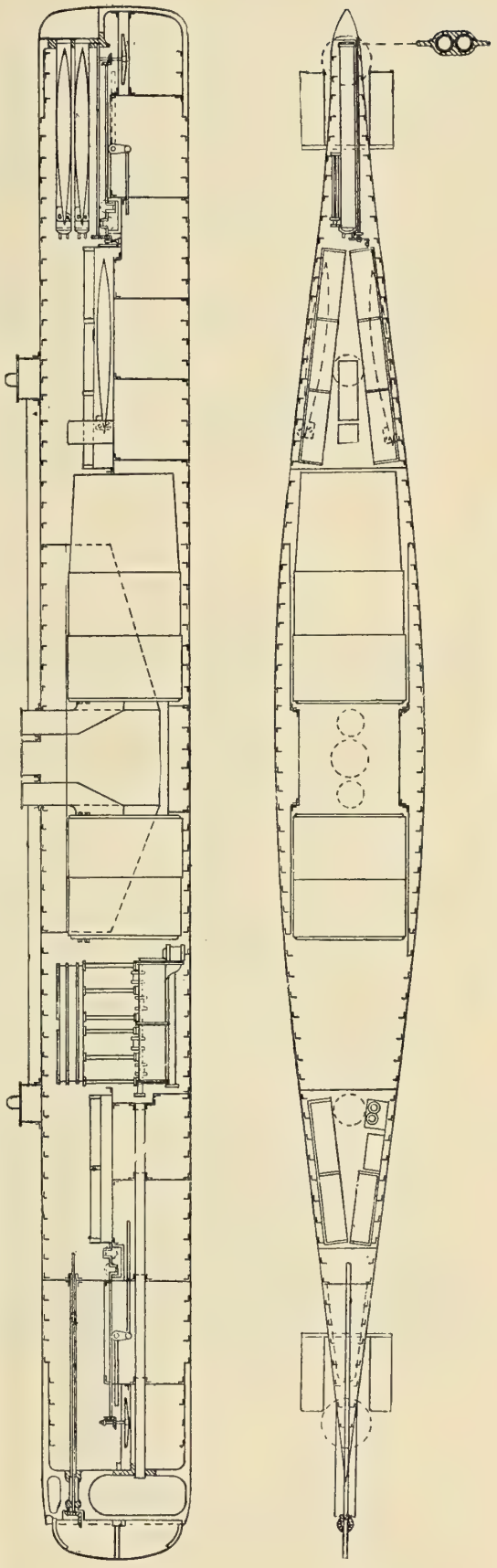
FIGS. 33-42—NORDENFELT'S BOATS FOR TURKISH GOVERNMENT, 1887.

*Translated from the Proceedings of the Germany Society of Naval Architects and Marine Engineers, Berlin, Germany.

inder compound engine of 250 I. H. P. The tunnel shaft connection was by means of two knuckle joints, and the thrust bearing *a* was located immediately in front of the stern tube. The Scotch boiler was of ordinary type, with the exception that the smoke flue from the smokebox was carried through the top of the boiler in the steam space similar to a furnace flue. The idea of this was to economize head room in running the flue to the smokestack, which was fitted to the center of the boat, and, secondly, to prevent radiation of heat from the flue. When the boat is ready to sail beneath the surface the smokestack is removed, the furnaces are tightly closed by the cover *b*, and the manhole *d* in the deck is closed water tight. Then no more steam for the engine is taken from the boiler, but is taken from the storage tank *e*, which is filled with superheated water. To bring the water up to the temperature and pressure required, a coil of 450 sq. ft. of heating surface is fitted in the bottom of the tank, and this is fed previously by boiler steam, and the drains returned to the boiler by a special feed pump. The storage tank *e* and the boiler have a combined capacity of 30 tons of water, and the steam generated from this quantity was considered sufficient to propel the boat 30 to 40 miles when submerged. When diving, the water ballast spaces *g g g* are filled. The forward and after ballast tanks had a capacity of 15 tons each, and the middle tank only 7 tons. The boat then sinks up to the conning tower, and to completely submerge her the two vertical propellers *h h* are set in motion by means of two three cylinder Brotherhood steam engines. The boat was equipped with two torpedoes *i i*, which were placed forward on top of the boat, one above the other. In order to maintain a horizontal position under the water two horizontal rudders are fitted, and these were automatically controlled by two heavy lead pendulums, and also by an independent gear operated from the conning tower. There was no necessity in equipping these boats with means to replace the foul air when sailing under water, as they had such a large cubical capacity that the crew could easily breath the contained air for several hours. The boats had a number of trials in the Golden Horn at Constantinople, sailing on the surface as well as below, and it was reported that these trials were satisfactory. They are supposed to have attained a speed of 8 knots on the surface, and 4 to 5 knots below.

CHAPTER XVIII.

Nordenfelt's Boat for the Russian Navy, 1888.—Nordenfelt's last submarine boat—(Figs. 43 and 44)—was built in Barrow in the year 1887 and was intended for the Russian Navy. It was 125 ft. long, 12 ft. beam, and had a displacement of 160 tons when sailing on the surface, and 250 tons when completely submerged. Under the last named condition it still possessed a buoyancy of one quarter of a ton. This boat was fitted with two conning towers mounted with glass, and two smokestack. Built entirely of mild steel, the bottom plating was 1-2 in. thick and the deck plating was 1 in. thick, to protect her against the fire of machine guns. The coal capacity was 8 tons, and when the water ballast was removed this could be increased to 28 tons, which was supposed to be sufficient to drive her 1,000 miles at a speed of 8 to 9 knots. After her trial trip at Southampton, Dec. 19,

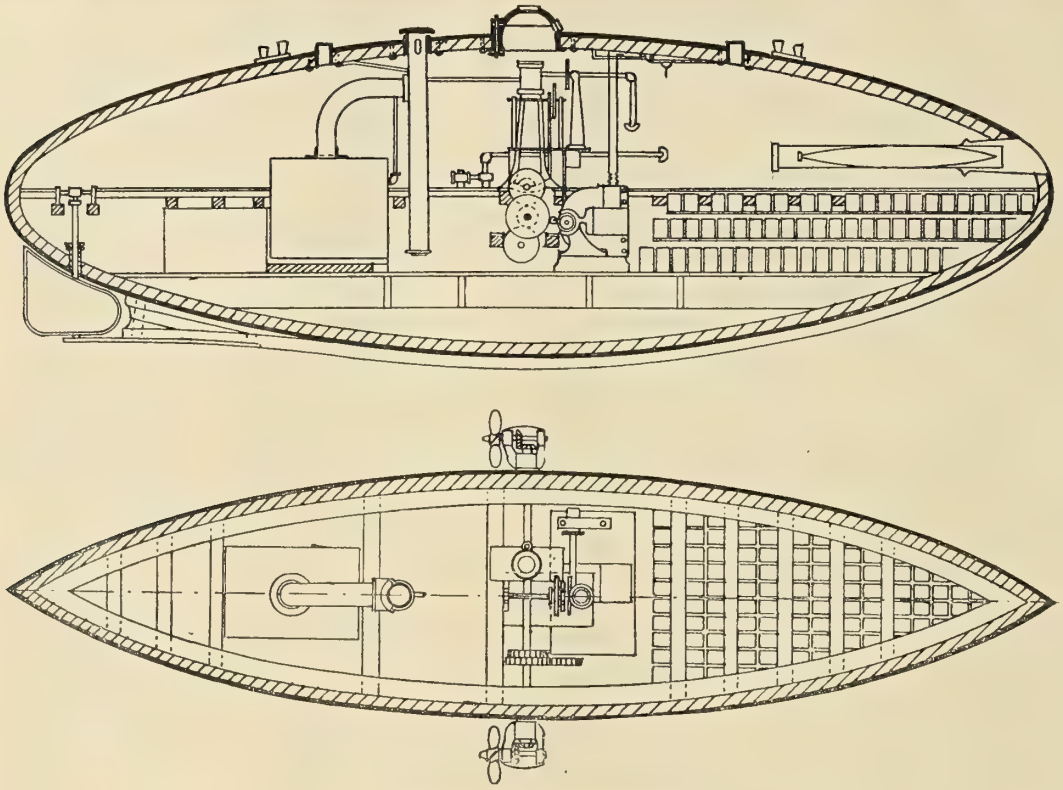


FIGS. 43, 44—NORDENFELT'S BOAT FOR RUSSIAN NAVY, 1888.

1887, she started for Kronstadt, and was lost in a gale in the Baltic Sea in the beginning of the year, 1888.

CHAPTER XIX.

Baker's Boat, 1892.—On November 26, 1892, Baker, an American, tried the submarine boat shown in Figs. 45 and 46, without much success. It had a length of about 46 ft. and a depth of about 9 ft. and a displacement of 20 tons. The skin of the vessel was of wood, covered with tarred canvas to make it perfectly water tight, and then a final protection of sheet iron. Her means of propulsion consisted of two propellers fitted



FIGS. 45, 46—BAKER'S BOAT, 1892.

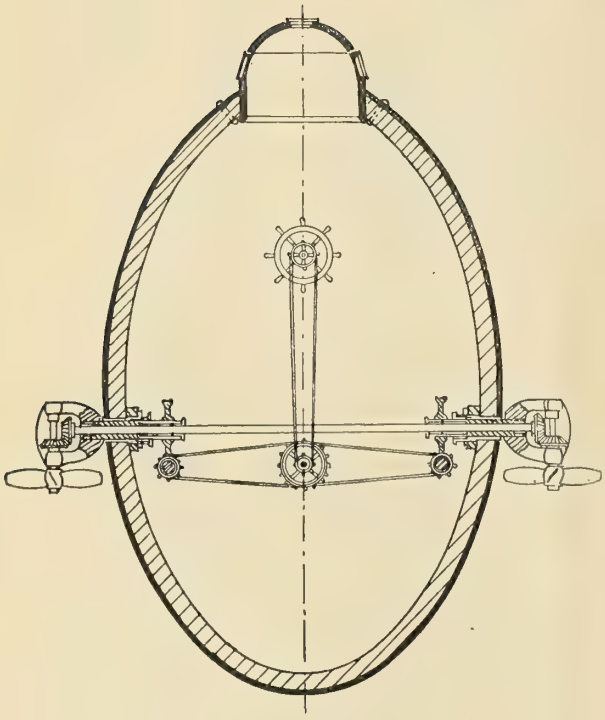


FIG. 47—DETAIL BAKER'S BOAT.

on either side amidships. These were driven from inboard by means of shafts and bevel gears, and, furthermore, the gear casings were connected to a worm gear and sprocket chain motion inside in such a manner that the casings could be swung through an angle of 90

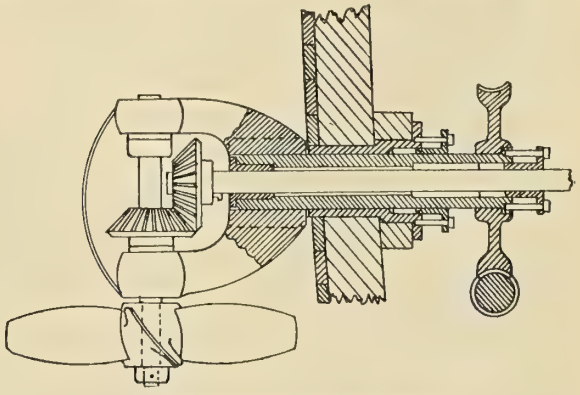


FIG. 48.—DETAIL BAKER'S BOAT.

deg., as shown in Figs. 47 and 48. Thus the propellers could be set either horizontal or vertical and they could be used either for propulsion or raising or depressing the boat. When she sailed on the surface the propellers were driven by a 6 H. P. steam engine. When sailing under water the smokestack of the boiler

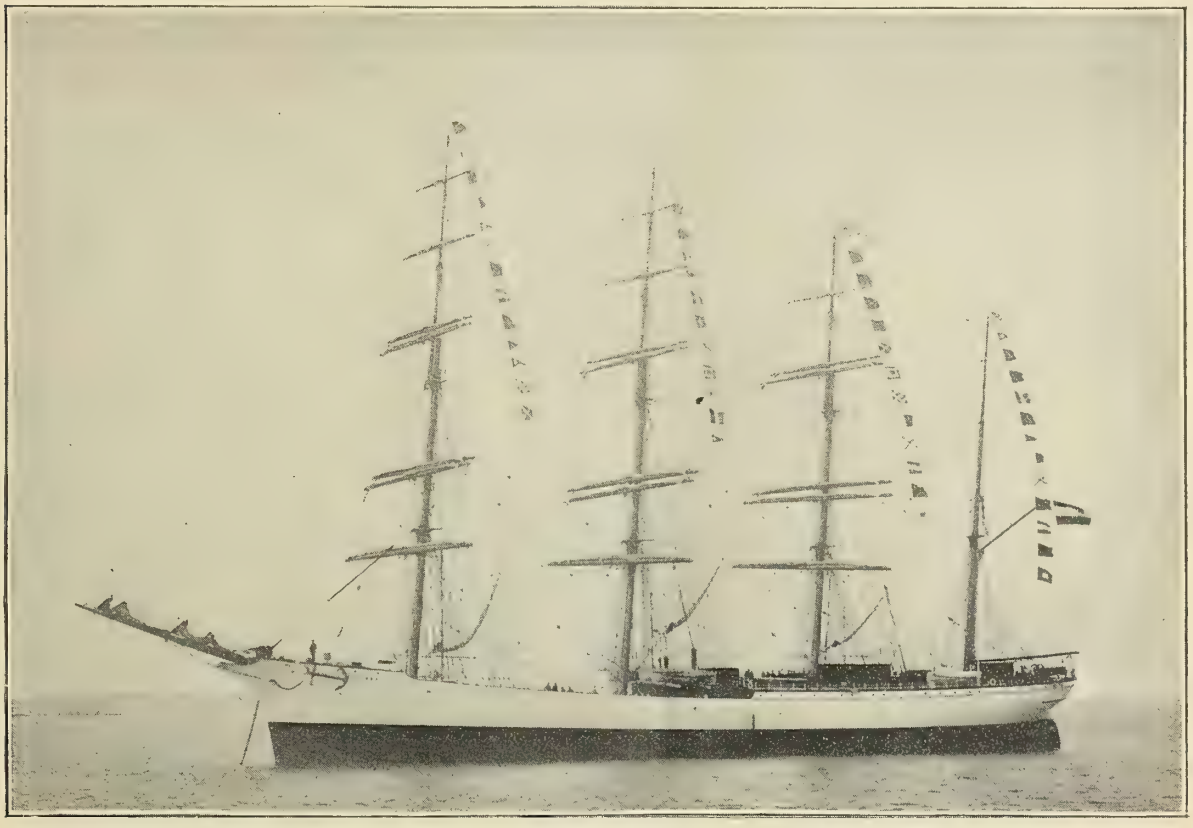
was drawn in and the opening closed water tight. The propellers were then driven by a 50 H. P. motor, which was fed by 232 Woodward storage batteries, subdivided into four main batteries which could be connected singly or together in order to vary the speed of the boat. While at the dock or when sailing on the surface the storage batteries could be charged by the motor by means of the steam engine. To depress or raise the boat, water ballast was pumped in or out by means of a Worthington duplex pump, which was also used for boiler feed. In the forward part of the boat, above the storage batteries, a tube was fitted for discharging Whitehead torpedoes. After making various improvements, Baker made further trials on August 31, 1893, but the results were so unpromising that the officials of the U. S. Navy, who were interested in the project, decided to abandon it and to devote their attention to that of Mr. Holland, which will be described in a further chapter.

North German Lloyd Training Ship.

It is not often that so successful a combination of the purely educational with the strictly commercial is found as in the case of the North German Lloyd cadet schoolship *Herzogin Sophie Charlotte* which is illustrated in the accompanying engraving. This fine sailing vessel, rigged as a four masted bark, is the training school for deck officers of the North German Lloyd Steamship Co. and from its decks will graduate the future commanders of the great transatlantic flyers. It is a steel vessel of these dimensions: Length, 276 ft. 2 in.; beam, 43 ft. 1 in.; depth, 25 ft. 5 in., and gross tonnage, 2,395 tons.

Sometime ago, when the company commenced those surprising additions in numbers to its fleet of steam vessels, a great dearth of candidates suitable for positions as deck officers on the new vessels was met with. This caused the management to attempt the plan of training its own cadets, and for the purpose a large sailing ship was selected. It was argued that on a sailer, the youth would acquire courage, quickness of preception, rapidity of execution, and bodily vigor to a greater degree than on a steam practice ship. The management also determined to combine thrift with science, and therefore selected a vessel of good carrying capacity, which could pay her way as she sailed about the world. Not long since the *Herzogin Sophie Charlotte* called at Philadelphia, and there loaded 10,000 cases of oil for Japanese consignees, and from the far East she will come across the Pacific and load a cargo of grain at Portland, Oregon, for Bremen.

To gain admission to the ship, the youth must have attended school in Germany, and have graduated with a diploma giving him the privilege of serving only one year in the German Army. About fifty cadets are admitted each year, and the course lasts three years on the training vessel. During the first year the cadet is classed as a boy, the following year he is graded as a seaman, and after two years of satisfactory service becomes an able seaman. At the close of the third year the cadet is transferred to one of the steamships of the company and there performs



NORTH GERMAN LLOYD TRAINING SHIP THE HERZOGIN SOPHIE CHARLOTTE.

the duty of quartermaster. At the close of this period afloat the cadet is admitted to the school of navigation at Bremen for a four months' course of study. He is then eligible for the examination for mate and if successful is appointed a fourth officer on one of the North German Lloyd steamships. It has been the experience of the company, we are informed, that a more desirable class of officers is secured in this way than could be had by the old haphazard process of selection from apprentices of the regular merchant marine.

LAUNCHES—HOME AND FOREIGN.

U. S. S. Macdonough.—The torpedo boat destroyer *Macdonough* was launched at the yard of the Fore River Engine Co., Weymouth, Mass., on December 24. She was christened by Mrs. Lucy Macdonough Reade. The *Macdonough* is one of the sixteen destroyers authorized by Act of Congress of May 4, 1898, and is of these dimensions: Length on load water line, 240 ft. 10 in.; extreme beam, 22 ft. 3 in.; mean draft, 6 ft. 1 1-2 in.; displacement, 400 tons; gross tonnage, 431.20 tons. She will be fitted with twin screw vertical inverted triple expansion engines and water tube boilers. Her armament will consist of two long 18 in. Whitehead torpedo tubes, two 3-in. R. F. and five 6-pdrs., R. F. Her complement will be four officers and sixty-nine men. The contract price for hull and machinery was $281,000.

S. S. Wilkesbarre.—The steel steamship *Wilkesbarre*, built for the Lehigh Valley Transportation Co., was launched at the yard of the Union Dry Dock Co., Buffalo, N. Y. She is of the following dimensions: Length on spar deck, 401 ft.; between perpendiculars, 381 ft. 6 in.; beam, 50 ft.; depth, 28 ft. She will have a quadruple expansion engine, with cylinders 20 1-2 in., 30 in., 43 1-2 in. and 63 in. dia. and 42 in. stroke. Steam will be supplied by three cylindrical boilers each 12 ft. 6 in. dia. by 11 ft. 6 in. long.

Sch. Van Allens Boughton.—The five masted schooner *Van Allens Boughton* was launched from the yard of H. M. Bean, Camden, Me., recently. She was built for Capt. John G. Crowley, who will act as managing owner. This schooner is the sixth one in the big fleet that Capt. Crowley now controls, all of which are in the coal carrying trade. She is of the following dimensions: Length of keel, 250 ft.; beam, 46 ft.; depth, 22 1-2 ft. Her frame is of Virginia white oak and the planking and ceiling hard pine.

Astral.—The four-masted steel ship *Astral* was recently launched from the yard of Arthur Sewall & Co., Bath, Me., for the Standard Oil Co., of New York. She will be used in the oil carrying trade and for general cargo and is of these dimensions: Length, 332 ft.; beam, 45.3 ft.; depth, 26 ft.; gross tonnage, 3,206.47. The *Astral* is built to carry 1,500,000 gal. of oil.

S. S. Suevic.—The White Star liner *Suevic* was launched at the yard of Harland & Wolff, Belfast, Ireland, recently. She is of the following dimensions: Length over all, 565 ft.; beam, 64 ft.; gross tonnage, 12,400 tons.

Sch. Pendleton Sisters.—The three masted schooner *Pendleton Sisters* was launched from the yard of Carter & Pendleton, Belfast, Me., recently. The vessel is owned by Fields Pendleton, of Islesboro, and will be managed by Pendleton Bros. She is of the following dimensions: Length, 175 ft.; length of keel, 160 ft.; beam, 37 ft. 9 in.; depth of hold, 18 ft. 9 in. The vessel registers 798 gross tonnage. Her masts are of Oregon pine, 93 ft., with a thickness of 27 and 28 in. at butt.

Yacht Rosina.—One of the finest yachts ever built in Lynn, Mass., was launched from the yard of Allan Hay. She was christened *Rosina* by Miss Lizzie Hay. The *Rosina* is of the following dimensions: Length over all, 60 ft.; beam, 17 1-2 ft., and is schooner rigged. She will be handsomely furnished and taken from Lynn to Atlantic City, from which place the owner, Henry Maplass, of Philadelphia, will sail for a cruise to Florida and possibly Cuba.

S. S. Neptune.—The steamer *Neptune*, building for the Globe Steamship Co., was successfully launched at the yard of the American Shipbuilding Co., at Lorain, O. The christening ceremony was performed by Miss Florence Osborne. The *Neptune* is 360 ft. over all; 346 ft. keel; beam, 48 ft.; depth, 38 ft. She will be fitted with triple expansion engines, and steam will be supplied by Scotch boilers 13 ft. dia. by 12 ft. long. The new boat will carry about 5,000 tons.

Consolidation Rumors.—Another rumor that the consolidation of the English firm of gunmakers and shipbuilders, Vickers Sons & Maxim, with the firm of Cramp of Philadelphia has gone the rounds of the daily press. The scope of the scheme was on this occasion enlarged to take in the Midvale Steel Co. The capital given was $20,000,000, of which $10,000,000 were to be six per cent preferred stock.

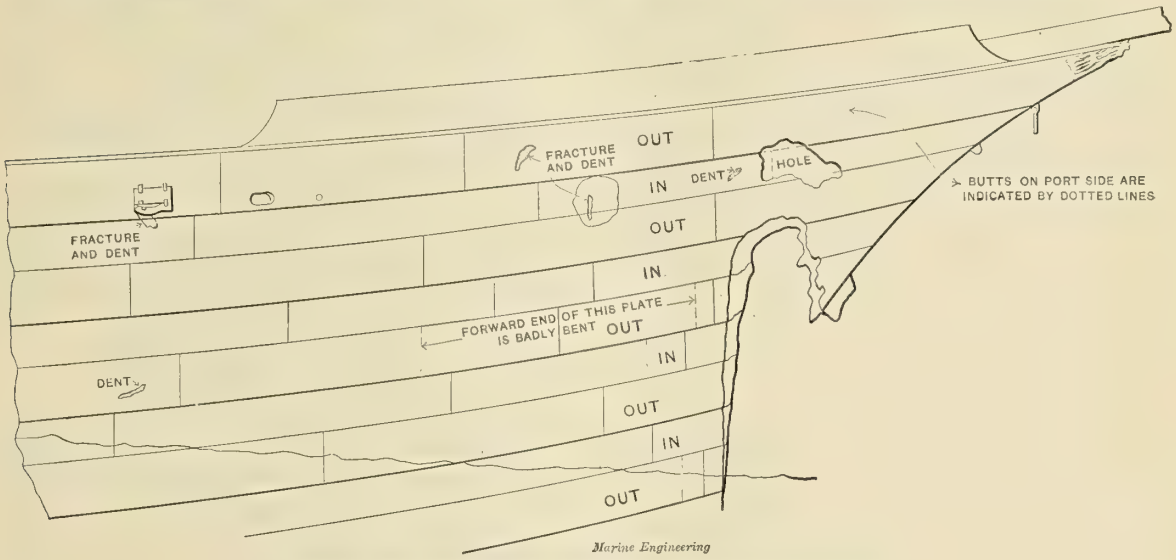
Bark Abby Palmer After Collision.

On the morning of November 6 last the American bark *Abby Palmer* and the Canadian Pacific mail steamer *Empress of Japan* collided in the straits of San Juan de Fuca during a heavy fog, and the sailing vessel sustained the damages shown in the accompanying photograph and sketch. The steamship was going at a good rate of speed when the bark struck her amidships. Exact particulars of the damage sustained by the *Empress of Japan* have not been made public, but apparently she was not badly damaged, for though she put back to port after the collision she soon resumed her regular runs. An examination of the illustrations will show that the sailing ship was pretty badly used up above the water line, the stem and fore ends of the plating being bent around to port and the bowsprit bent to almost a right angle with its normal direction.

The *Abby Palmer* was on her way from Honolulu to Port Townsend, and she at once proceeded to Seattle, where the work of repair was entrusted to the Moran Bros. Co. This was carried out with the aid of a coffer dam, which reached under the keel for about 20 ft. abaft the stem.

This bark seems to have had a run of bad luck since

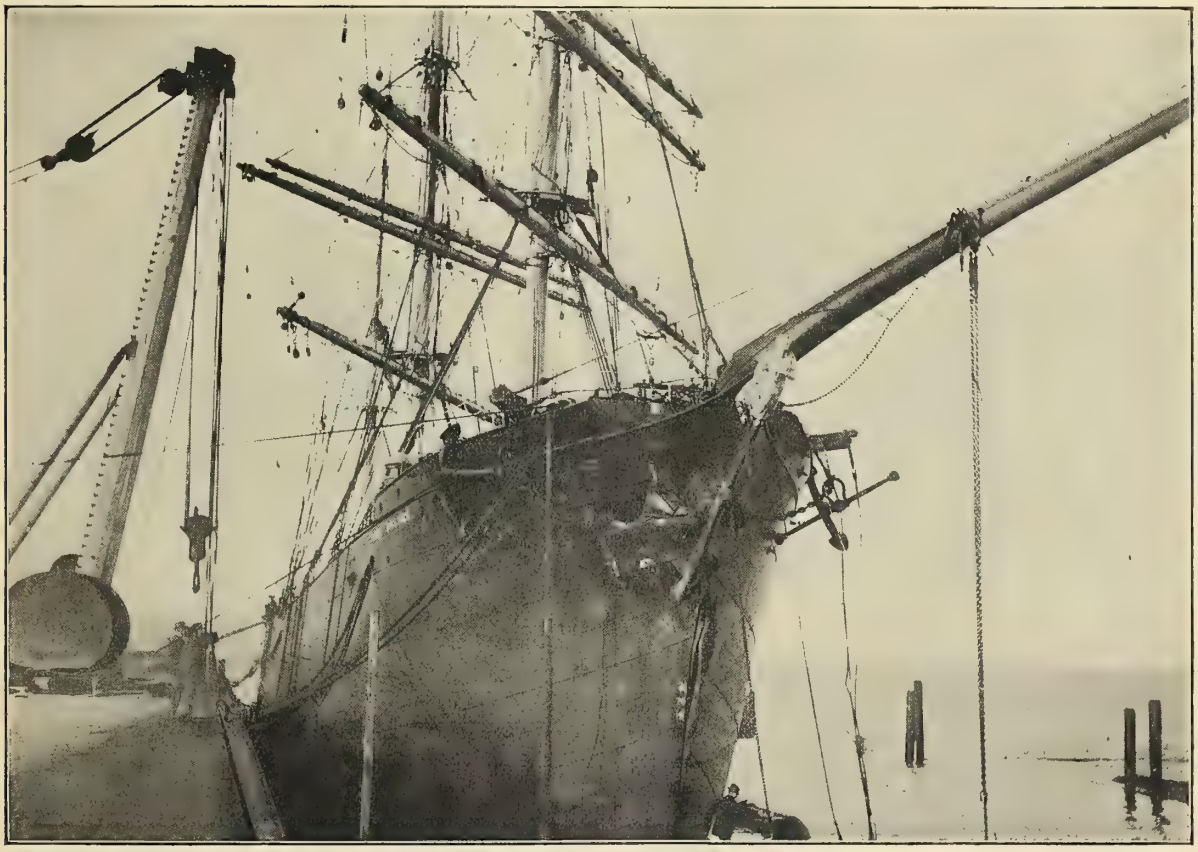
she was launched at Dumbarton on the Clyde in 1893. She was originally named the *Blairmore*. In April, until litigation between the owners and underwriters was settled. When refitted she got a new name. Sev-



SKETCH SHOWING INJURIES SUSTAINED BY BARK ABBY PALMER.

1896, while at anchor in San Francisco Bay, she was capsized by a sudden squall, and the first officer and six of the crew, who were down in the hold, were drowned. The vessel was subsequently raised and lay on the mud for a long time in a dismantled condition

eral months ago she was in collision with the S.S. *Belgian King*. The *Abby Palmer* is a steel vessel of these dimensions: Length, 264 ft.; beam, 39 ft.; depth, 23 ft. 5 in., and gross tonnage, 1,767 tons. She now has American registry.



PHOTOGRAPH OF AMERICAN BARK ABBY PALMER AFTER COLLISION WITH S.S. EMPRESS OF JAPAN.

PRELIMINARY SPEED TRIAL OF THE U. S. TORPEDO BOAT STOCKTON.

For the U. S. S. *Stockton* the claim is made that she is the first torpedo boat ever built in this country to have attained the contract speed on the first trial. This is no small achievement when it is considered that the builders have had no extended experience in this class of work, and also when the long trial period necessary in the case of some U. S. torpedo boats is considered. This boat is also the first of the twelve torpedo boats authorized in 1898 to be ready for trial. Her builders, the William R. Trigg Co., of Richmond, Va., have been widely congratulated on the results they have thus achieved.

The chief dimensions of the boat are:

Length extreme	175 ft.
Length on water line	175 ft.
Beam extreme	17 ft.
Draft mean	5 ft. 3 in.
Displacement	165 tons
Coal capacity	80 tons
Water tank capacity	2,000 gals.

The boat is fitted with water tight bulkheads, the collision bulkhead being 10 ft. abaft the stem. This compartment forward may be used for a trimming tank, it having a capacity of 3.7 tons.

The after tank holding 10 tons may also be used for trimming purposes. The crews' quarters are aft, and the ward room forward. The captain's cabin has one berth, and the ward room two and a dining table. Directly aft of the ward room is the pantry, bath room and engineers' stateroom. The quarters are small, but much more comfortable than one would suppose.

The machinery space is divided into four water tight compartments, the forward fire room containing two boilers, the forward engine room, the starboard engine and the after engine room the port engine. The after fire room contains one boiler. The main shaft runs under the after boiler.

There are two conning towers, one forward and one aft, containing duplicate steam steering gear, and communicating by voice tubes to all parts of the ship. The boats carry three torpedo tubes, one away aft and the other two on the sides amidships.

The engines are of the inverted direct acting, triple expansion, four cylinder, type of 1,500 I. H. P. each, when turning at 350 revolutions per minute under 250 lb. steam pressure. Each engine is fitted with a separate condenser of 1,250 sq. ft. cooling surface—steam outside of the tubes. The main injection water is forced through the condenser by the movement of the boat, supplemented by a small circulating pump. There are two main feed pumps and one auxiliary, and a fire and bilge pump. There are two evaporators sufficient to make up feed under ordinary cruising conditions.

There are three stacks, one to each boiler. The grate bars are of wrought iron, about 3-16 in. thick, riveted together in groups of six. These bars act very well under forced draft, but a very small hole in the fire will immediately melt and run them down. Forced draft is used with a closed stokehold, making very comfortable fire rooms with hatches down.

The three boilers are of the Thornycroft "Speedy" type. Particulars of the boiler are a follow.:

Grate surface	45.6 sq. ft. one boiler.
Heating surface	2,516 sq. ft. one boiler.
Ratio G. S. to H. S., 1 to	55.2
Weight of boiler dry	9.70 tons.
Weight of boiler wet	11.45 tons.
Weight per sq. ft. of H. S.	8.63 lb. without water.
Weight per. sq. ft. of H. S.	10.2 lb. with water.
Area of one stack	5.74 sq. ft.
Tubes diameter	1⅛ in. and 1¼ in. outside No 11 B.W.G.

There are three blowers, two in the forward and one in the after fire room, of a combined capacity of about 25,000 cu. ft. of air per minute—2 1-2 in. water pressure. These blowers are 42 in. dia., turning 600 revolutions per minute, and are fixed horizontally under the deck.

The propeller is the one first designed for the boat and has proved very efficient. It is 9 ft. pitch; 5 ft. 8 in. dia., with a developed area of about 10 1-4 sq. ft.

The engine weights are as follows:

Engine room and stern weights dry	35.75 tons.
Engine room and stern weights wet	39.03 tons.
Forward fire room weights dry	25.61 tons.
Forward fire room weights wet	29.40 tons.
After fire room weights dry	13.07 tons.
After fire room weights wet	15.02 tons.
Summary with water, stores, and miscellaneous machinery:	
Engine room and stern weights	39.03 tons.
Fire room weights	44.42 tons
Tools, stores, etc	2 91 tons.
Distilling and heating plant	2.41 tons.
Total	88.77 tons.

There are deducted from this about four tons for stores, etc., that are not carried on the boat, leaving a total of 84.77 tons of 2,240 lb. Hull weights, equipment and ordnance foot up about 89 tons.

The preliminary trial took place in Chesapeake Bay opposite Cape Charles City, on November 6. The Government course extends in a direction N. N. W.—5-8 W to S. S. E.—5-8 E. The wind was light and the sea smooth, with a strong ebb tide of about three knots N. by E. to S. by W. The average length of the course was 1.05 knots.

Four runs were made, the boat turning in a circle at full speed after each run. The average speed was 26,-438 knots for a 45-minute run.

Observed data showed:

Average revolutions	360	
I. H. P.	3,174	
M. E. preferred to I. P.	48.7	
Slip	17.5	per cent.
I. H. P. per sq. ft. preferred G. S.	23.2	
H. S. per I. H. P.	2.38	sq. ft.
Pounds total of machinery including water per I. H. P.	59.8	
Boiler pressure	245	lb.
Vacuum	22	in.

The result showed an increase of nearly one-half knot over contract, with something in reserve. The safety valves blew off at 245 lb. during one of the runs. Since the foregoing was written the vessel has had her official trial, and has failed to come up to expectations—she was, however, considerably overweighted.

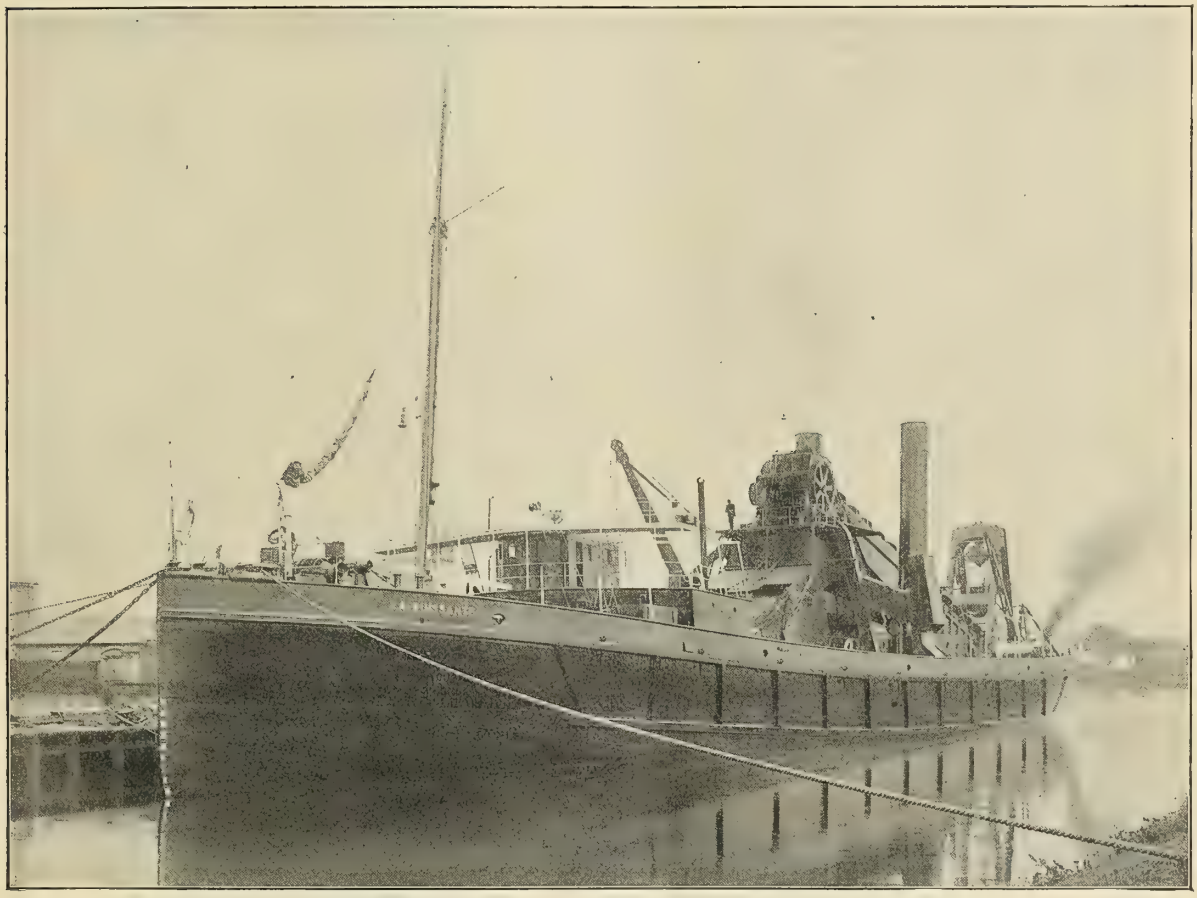
Hopper Dredge La Puissante.

In the accompanying engraving is shown the huge hopper dredge *La Puissante*, built by William Simons & Co., of Renfrew on the Clyde, to the order of the Suez Canal Co. for the improvement of the Port Said Roads. The vessel is of these dimensions: Length between perpendiculars, 226 ft.; beam molded, 47 ft.; depth molded, 19 ft.; draft loaded, 16 ft. 5 in.; hopper capacity, including coamings, 2,200 tons. The dredger is of the stern well bucket type, and is capable of excavating a channel 40 ft. deep. The buckets have a capacity of 30 cu. ft., and the contract dredging capacity of the vessel is 1,150 tons an hour, though on trial 1,600 tons of material have been handled in the same time.

Mild steel is used for the hull, which is divided into twenty-three water tight compartments by eight transverse bulkheads carried up to the deck. For regulating the trim of the vessel, a forward tank is fitted, and there are also four ballast tanks, two on each side of the hopper space.

The *La Puissante* is fitted with twin screws, the engines being located immediately aft of the hopper space and forward of the boilers. The engines are of the triple expansion type, with cylinders 17 in., 27 in. and 43 in. dia. by 27 in. stroke. Boilers, of which there are two, are of the Scotch type, 14 ft. 6 in. dia. and 11 ft. long, built to withstand a pressure of 160 lb. By an arrangement of gears each set of engines can drive the dredging gear independently at two different speeds—sixteen and twenty buckets a minute. The bucket ladder weighs about 120 tons, and it is fitted with buffer springs at the upper end to lessen shock when working in a sea way. The ladder is raised or lowered by a 10-sheave wire rope purchase, the handling gear being located on a flat aft and operated by independent double cylinder engines.

On trial the dredge attained a speed in excess of 9 knots, and on 6 hours' steaming trial a rate of coal consumption of 1.66 lb. was recorded. The dredge was built under Bureau Veritas Special Survey.



HUGE HOPPER DREDGE LA PUISSANTE, BUILT ON THE CLYDE FOR THE SUEZ CANAL CO.

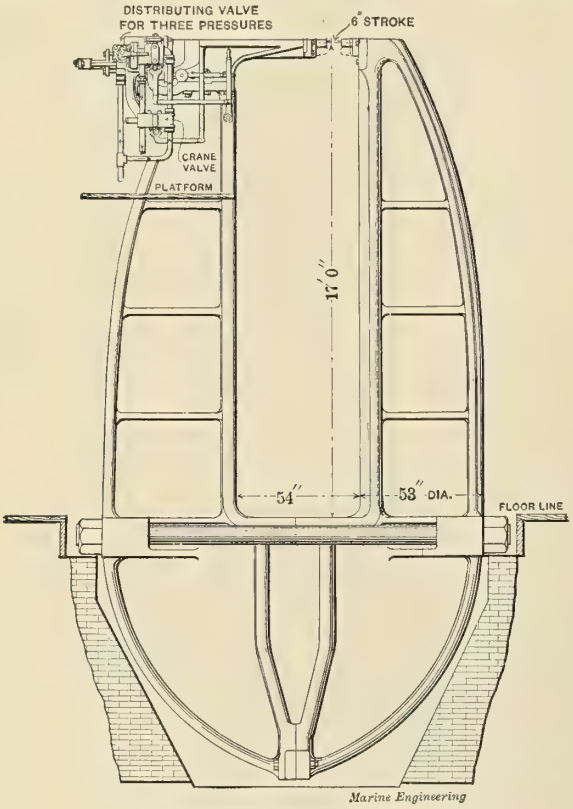
Immigrant Depot.—The new immigrant station at Ellis Island, New York harbor, built to replace the old structure, which was burned some time ago, has been opened for the reception of immigrants. The new structure is very strongly built and is of large and imposing appearance. The Sound steamer *Narragansett*, which has been used as a receiving station, has been put out of service, and it is reported that she will be broken up.

A new record for the New York-Havana trip has been made by the Ward liner *Morro Castle*, which recently cut down the time on the return trip to 2 days, 14 hours and 32 minutes. The distance is 1,215 nautical miles.

IMPROVED APPARATUS.

Stationary Hydraulic Riveter.

In the accompanying line drawing there is shown a fixed hydraulic riveter with bolted frame, which has been designed by the Chambersburg Engineering Co., Chambersburg, Pa., for heavy marine work. This is of the hemp packed type, so arranged that to renew the packing it is not necessary to take the machine adrift, but the packing can be inserted very readily without any delay. The packing is set up by outside glands which are readily accessible at all times. The frames are extremely heavy and rigid and so designed that deflection is reduced to a minimum. The stake is circular in section, allowing the greatest depth for the smallest possible diameter. The ram is so arranged that it is flush both on top and bottom, a desirable

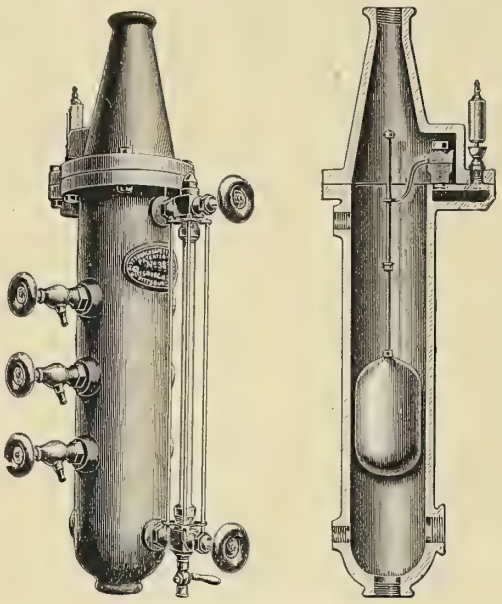


CHAMBERSBURG HYDRAULIC RIVETER.

feature in a machine of this character. These machines are carried in stock so that in the event of a breakdown it will be possible to get a new part without delay. The depth of the gap of the machine shown is 204 in. and the width 54 in. The stroke is 6 in. The riveter is designed so that it can be used either with a single pressure or three pressures, with a capacity for a total pressure of 130 tons.

Safety Water Column.

The safety water column which is applicable to marine work, especially in smooth waters, has been brought out by the Pittsburg Gage and Supply Co., Pittsburg, Pa. It is arranged, as the drawing shows, so that when the water falls below a safe level, the float automatically opens an escape valve and a whistle is blown, calling attention to the low water in the

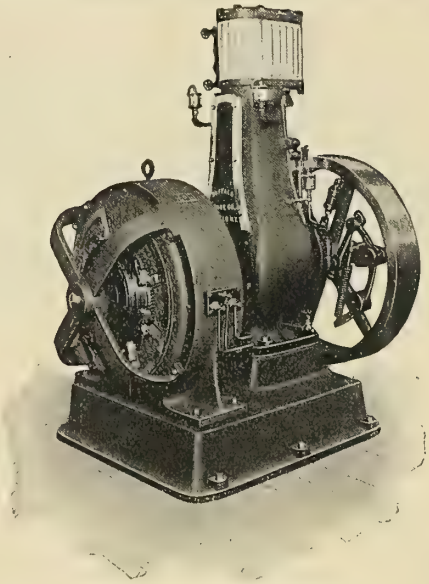


PITTSBURG WATER COLUMNS.

boiler. The apparatus is very simple, and its application in no way interferes with the ordinary and usual functions of the water column.

Direct Connected Generating Set.

The accompanying illustration shows a standard upright engine manufactured by the Buffalo Forge Company, of Buffalo, N. Y., and connected to a generator of the Triumph Electric Company's make, though it will be understood, of course, that any standard dynamo may be so connected. The rigid cast iron frame of the upright inclosed type has one cylinder



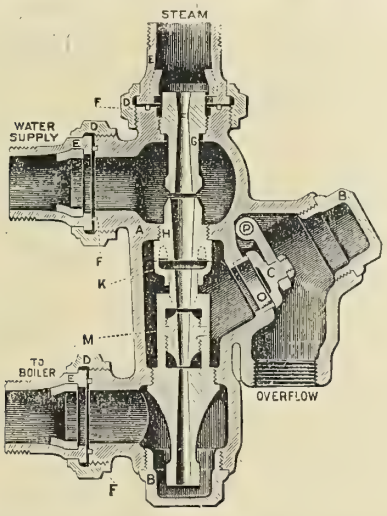
BUFFALO FORGE LIGHTING SET.

head cast as a part of it, and to this is bolted the cylinder and steam chest, though in the smaller sizes the cylinder also is cast on the frame. Cylinder and

guides are bored with the same setting of the boring bar, so that perfect alignment results. The material employed throughout is the very best attainable, while the workmanship is high in like degree. A feature of this engine is that it is inclosed to run in oil, so that perfect lubrication of the main bearings, crank pin, wrist pin, and guide is assured. Other bearing surfaces are cared for by continuous oilers of large capacity, and for the cylinder and steam chest a large sight feed lubricator is provided. As a result of this thorough system, smooth running at continuous high speeds is readily possible. Another feature which renders this engine valuable for high speed lighting and power service is close regulation. This is afforded by a centrifugal flywheel governor of great sensitiveness. The latter property follows in part from the careful design, which provides three means of adjustment for the governor, and in part, also, from the provision of ample lubrication for all the governor pins and rubbing surfaces of the valve motion. The valve is of the piston type, perfectly balanced. With this type of engine the direct connected generating set occupies very small floor space, and is specially adapted for marine use for this reason. It is made in a range of sizes from 4 to 100 H. P.

Lunkenheimer Injector.

A new form of automatic injector has been put on the market by the Lunkenheimer Co., Cincinnati, O. This injector is made in the body of cast iron, and the tubes are of a specially hard bronze composition, and are so constructed that there are no spill holes in the walls. All the tubes and wearing parts are made interchangeable, so that they can be readily replaced with new ones at any time. The steam suction and discharge connections are provided with male unions, and the joints where the unions connect to the body are made of the smallest copper rings. The joints are very tight and are guaranteed to withstand all conditions of usage, as the body of the injector is very rigid, and not liable to distortion by expansion of connecting pipes. The construction of the injector and



its exterior appearance will be plainly seen in the accompanying engravings. The several parts are indicated by reference letters, *A* being the body of the injector, *B* the overflow or delivery cap, *C* the overflow valve, *D* the union rings for connecting to the water and delivery to the boiler, *E* and *F* indicating the union tail piece, *G* is the steam tube, *H* the water lifting tube, *K* the automatic valve, *M* the combined delivery tubes, *O* and *P* the overflow valve seat and pin. The injectors are made in a variety of sizes for connection, from 1-2 in. to 2 in. Before leaving the works each injector is tested with a 3 ft. lift and steam pressure ranging up to 95 lb., the temperature of the feed water being 75 deg. Fah.

Obituary.

Lord William Armstrong died, December 27, at his English residence. He was the principal owner of the great Elswick works at Newcastle-on-Tyne, England. His name will always be associated with the modern rifle ordnance and with the modern methods of hydraulic engineering. In his early life the deceased followed the profession of law, but, his attention having been turned to engineering, he established the works which finally grew to be one of the largest engineering establishments in the world. He was connected with almost all of the scientific societies in Great Britain, and had been honored by foreign societies and governments. He was born in the year 1810.

James Shreves Doran, superintending engineer of the International Navigation Co., died suddenly at his home in Philadelphia on December 17, from a stroke of apoplexy. The funeral service took place in the Spring Garden Unitarian Church, Philadelphia, and was largely attended by friends, together with deputations from the offices of the International Navigation Co., and from the Cramp and Newport News yards. Mr. Doran was born in Bucks County, Pa., in 1834, and in his youth was apprenticed as a machinist, and later went to sea as a marine engineer. Later he became connected with the American Steamship Co., as assistant superintending engineer under Superintending Engineer William Marshall. Upon the death of Mr. Marshall about twenty years ago, Mr. Doran succeeded to the position, which he retained to the day of his death, the company with which he was originally connected being merged into the present corporation.

Rear Admiral Frederick V. McNair, U.S.N., died suddenly of apoplexy at Washington early in December. He was the senior rear admiral of the navy, and would have reached the retiring age, 62 years, on January 13. It will be remembered that he was in command of the Asiatic squadron at the time that Admiral Dewey arrived out, and that he consented to be detached from the squadron, so that Admiral Dewey would be able to fly his flag. After his return from the Asiatic station, Admiral McNair was appointed superintendent of the Naval Academy at Annapolis, and while there had, as prisoners of war, Admiral Cervera and the officers of the Spanish vessels destroyed in the affair at Santiago. Last spring he was detached from the superintendency of the Academy, and has since been on waiting orders. He entered the navy from Pennsylvania in the year 1853. During the Civil War he saw service in the Gulf and South Atlantic squadrons, and participated in the attacks on Fort Fisher.

MARINE ENGINEERING

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PRACTICAL efforts to resuscitate the American merchant marine have been focussed in the measure known as the Ship Subsidy Bill now under consideration by Congress. Owing to the short time now before the close of the session, and the pressing necessity for consideration of other important bills, it is not likely that the bill will be passed before adjournment. As might be expected in the case of a measure, which, while indirectly of vital importance to every interest in the country, is at first glance directly for the benefit of the shipping interests only, its presentation has caused much opposition. Sides have been taken by leading newspapers of the country and the discussion instead of being helpful has become more and more full of obscurities, with charges and countercharges, vituperation and literary assault instead of clear headed argument. In all special legislation there is much to be said on both sides, depending to great extent upon the view point of the disputants, which in turn is located by their interests, their opportunities for observation and knowledge of the subject. Having this in mind, it can reasonably be believed that the champions of the measure and those opposed to it are actuated only by what they believe to be the best interests of the country, and yet they might be far from a real solution of the problem. A measure which would stop short of that, and which would be promoted only for pecuniary gain by its advocates, would be very disastrous to our prospective shipping interests. The cause of action freed of all technicalities and political bias is very simple. As matters now stand the United States pays about $200,000,000 a year in freight rates to foreign shipowners. To secure as large a share of this as possible for American shipowners, and incidently to build up a strong merchant navy which will carry the flag to the ends of the earth is the desired object. To accomplish this there is needed first, the creation of such a navy, and secondly, its operation, both in the face of the keenest competition. We are admittedly unable at this time to build ships as cheaply as the foreigner, and we are equally unable to operate them in regular service as cheaply as the foreigner can. These are the conditions in general, and it is to bridge over this gap in costs of construction and operation, so as to enable our owners to compete with the foreign owner and make a profit, that the aid of Congress is invoked. That, at least, is the purpose which those who look at the question broadly and practically have in mind. There have been different methods proposed by which the nation could fairly and equitably extend such help, and to do so and at the same time live up to its treaty obligations to other nations the ship subsidy has been proposed. In the bill now before Congress the authors seem not to have confined themselves to the single matter of expansion of the ocean freight carrying trade of the United States, but have inferentially incorporated other features, such as the carriage of passengers and mails, the creation of fast ships suitable for auxiliary cruisers, etc., in a parliamentary lucky bag —first come best served, and the man with the biggest hand wins. The result is that in trying to gratify every one they have succeeded in arousing fierce and unreasoning opposition to the whole scheme. It is more than probable that there is not a good citizen in the United States who, if he understood the question, would not favor the passage of a measure which would really expand the American merchant marine. Had those who drew up the bill sought to pass a measure for the relief of indigent shipowners, or for increasing the dividends of already existing regular lines, they would have done very well

indeed. Would it not be wiser, however, to concentrate effort at this time on the vessel of real importance to American prosperity? the humble, lowly, freight carrier, devoid of passenger accommodation, with no strong room for mails, and with machinery which will just keep her nose pointed straight in different sorts of weather. Of liners and such we have a fair supply at this time, of good modern freighters not a dozen afloat. Yet the bill discriminates against the very type of vessel with which we would be able to get our fair share of that $200,000,000 of over sea freights. The bill gives the maximum rate of subsidy to the fast ship and the minimum to the slow, the amount being figured on the gross tonnage. Thus the *St. Paul*, for example, with the maximum of sixteen voyages allowed by the bill, would earn on a gross tonnage basis $396,967.54 in subsidies in one year. Now this ship has cargo capacity for about 2,000 tons deadweight—actual freight sent down the hatches—so for carrying about 64,000 tons in one year she would earn nearly $400,000 over and above the freight charges paid by the shippers. The value of a vessel like the *St. Paul* as a carrier of mails in time of peace and as an auxiliary cruiser in time of war need not be underestimated, but it has no real place in the consideration of a measure for the expansion of the American ocean freight carrying industry. Let those matters be treated by other and suitable legislation, paying the owners of fast vessels proper remuneration for the carriage of mails, and such retaining fees for the privilege of requisitioning their ships as cruisers in war time, as will be just to all. If side issues are to be considered in the discussion of the freight carrying question, it will be proper to include in the subsidy bill a clause giving steam yacht owners certain bounties because they possess vessels which in war time would be of service. What is really needed is such aid as will induce capitalists to build and operate freight vessels, to form new companies and open up new lines of communication. Existing vessels of the intermediate type, whose chief function is to carry freight, and whose speed does not go beyond, say, 17 knots could be reasonably included in the provisions of such a bill. Luxuries like 21-knot liners offer no solution of the problem; it is the plain bread and butter winning freighter that is going to give us back our rightful place as a great maritime nation. On this issue, were all supporters joined, much of the present opposition would disappear.

WITH the simultaneous opening of the New Year and the New Century, the outlook for ships and shipping in the United States is very promising. The closing years of the last century have shown a remarkable growth of foreign trade of the United States. In fact, this trade is so secure and vigorous that it is causing genuine alarm in British and Continental circles. For a variety of reasons shipping is the last industry here to feel the benefit of this prosperity. It is very probable that it will receive a stimulus this year or next by the passage of some helpful measure by Congress. Turning to the year just closed the official record prepared by the Bureau of Navigation of the U. S. Treasury Department shows a considerable increase in actual construction over the preceding year. During the calendar year 1900 there were built in the United States 1,102 merchant vessels of 365,791 gross tons, an increase of 148 vessels and of 98,149 gross tons over the year 1899, for which the totals were 954 vessels of 267,642 tons. Of these totals steam vessels numbered 92 of 196,957 gross tons in 1900, and 86 vessels of 126,768 gross tons in 1899. The greater part of the increase, however, was not in ocean going vessels, but in the lake freight carriers. The increase on the Great Lakes was from 14 vessels of 50,836 tons in 1899 to 33 vessels of 108,511 tons in 1900. To the total for 1900 the Atlantic coast contributed 51 steel steam vessels of 78,982 tons, a less number by a dozen than in 1899, but an increase of actual tonnage amounting to 5,174 tons. On the Pacific coast there were built 6 steel steam vessels of 8,881 tons last year. In wooden sailing vessels there is an increase both in numbers and tonnage, from 523 of 86,125 tons in 1899 to 575 of 99,460 tons in 1900. The same is true of wooden steam vessels, of which class there were built in 1900 423 of 40,546 tons, as against 335 of 33,364 tons in 1899. Steel sailing vessels, including schooner barges, give a total of 12 of 28,828 tons, an increase from 1899, for which the figures were 10 of 21,385 tons. On the other side of the Atlantic an estimate of the year's construction gives a total of more than 1,500,344 gross tons of merchant shipping. The list is headed by the English yard of Wm. Gray & Co., East Coast builders, with 24 ships of 74,191 gross tons. Second in the list comes the Irish yard of Harland & Wolff with 67,845 tons. The top Scotch figures are 54,415 tons for Russell & Co., of Port Glasgow,

THE MARINE STEAM BOILER.

AN ELEMENTARY DISCUSSION OF THE PRINCIPLES CONTROLLING THE GENERATION OF STEAM.

BY DR. WILLIAM FREDERICK DURAND.

BOILER ECONOMY.

There may be several different bases for boiler economy according to the particular feature held in especial prominence. The output of the boiler is estimated in terms of the steam produced, and we may have the following kinds of economy:

(1) Economy in coal consumption, increasing with the output of steam per pound of coal burned.

(2) Economy in weight of boiler, increasing with the output of steam per pound of boiler.

(3) Economy in first cost, increasing with the output of steam per dollar invested in the boilers.

(4) Economy of maintenance or total life, increasing as the life of the boiler is longer and the amount necessary for repairs is smaller.

It is never possible to fulfil in the highest degree the conditions for these various kinds of economy, and a compromise must always be made among them, though usually (1) or (2) will take the first place in the order of importance.

Without special note, however, the term economy is understood to refer to (1), though the considerations relating to the others should always be kept in mind. In some cases, as in torpedo boat and like practice, (2) may assume first place in the order of importance, and, perhaps, require some sacrifice relative to the others. We will now consider more especially the economy referred to under (1).

From the standpoint of coal economy or efficiency, the boiler is charged with all the coal that is thrown through the furnace doors, and is credited with the steam which it sends to the engine. Or to state the matter more definitely, it is charged with all the heat which could be gotten from this coal by perfect and complete combustion, and is credited with the heat which is transferred through and actually used in the formation of steam. If the efficiency were perfect, or if there were no loss, these two amounts of heat would be equal. Actually there are many losses, large and small, and, in consequence, the latter is considerably less than the former. The ratio of the two is known as the *boiler efficiency*. In practice its value varies from 50 to 75 or 80 per cent. Following are the more important sources of loss which occasion this drop in efficiency.

In the first place, a little of the fuel may fall unburned through the grate into the ash pit. Again, a little in the form of dust and small bits may be carried by a strong draft, either unburnt or only partially burnt, through into the tubes, uptakes or funnel. Still another small portion may escape as smoke, which consists almost entirely of very fine particles of unburnt carbon formed from the gases which are distilled away from the coal in the process of combustion. Still another portion of these gases may escape unchanged and unconsumed. Again, there may be an incomplete combustion of the carbon forming *carbon monoxide*, and giving only about 4,450 heat units per pound, instead of 14,500 which result from the complete combustion into *carbon dioxide*. Hence, whatever carbon escapes in the form of carbon monoxide is only partly burned, and may be considered as carrying away over two-thirds of the heat which would be liberated by complete combustion. These losses all occur in the furnace, and are due to poor firing and to imperfect combustion.

To reduce them to the lowest limit, the fireman must know his business, and be willing to attend to it with ceaseless care and diligence. In addition, there must be provided, by proper design, the necessary supply of air both above and below the grate, together with such arrangements as experience may show are needed for good combustion with the fuel in hand. At best this loss may be reduced to perhaps 2 or 3 per cent, while with carelessness or poor design, or both, it may easily reach values from 10 to 20 per cent.

The heat being thus more or less perfectly liberated in the furnace, is then passed on to the boiler heating surface, whose duty it is to transfer it through into the water on the other side. The energy is still to exist as heat, but it is to be transferred from the hot gas to the water, thus converting the latter into steam. This, however, cannot be perfectly accomplished, and thus arises a further loss. A part of the heat, instead of passing through the heating surface, goes up the funnel carried by the escaping gases, and so gets away into the outside air. Another and smaller part escapes by radiation into the fire room. These losses it is impossible wholly to avoid. It would be necessary to avoid all loss of heat by radiation, and to reduce the temperature of the products of combustion in the funnel to that of the outside air. The latter, especially, cannot be done for the best of reasons. In the first place, the temperature cannot be reduced below that of the steam and water in the boiler, because heat always flows naturally from a hot body to a cooler one, and it will, therefore, flow from the gas to the water only so long as the latter is the cooler of the two. The actual temperature of the escaping gases must be considerably higher than that of the steam, because in the first place sufficient heating surface to reduce them to nearly the same temperature could hardly be allowed; and, again, aside from blowers, the strength of draft is dependent on the temperature of the hot gas in the funnel, and for a satisfactory rate of combustion it is necessary to discharge the products of combustion at temperatures not less than 500 to 600 degrees. This loss is one therefore which exists in the nature of things, and cannot be reduced below some 20 or 30 per cent.

On the whole, then, the entire losses under the best conditions can hardly be reduced much below 25 per cent, while with poor conditions they may aggregate 40 to 50 per cent. The remaining fraction, or the 50 to 75 or 80 per cent, represents then the efficiency of the boiler as defined above.

Since a pound of average good coal has available some 13,000 to 14,000 heat units, it follows that the heat actually utilized per pound of coal is usually found between say 7,000 and 11,000 units.

In general the conditions favorable to high efficiency are the following:

(1) A free burning coal of good quality, with suitable furnaces and air supply for complete combustion.

(2) Moderate draft.

(3) Abundant heating surface.

Or, as a combination of (2) and (3), we may put:

(2) Moderate evaporation required per square foot of heating surface.

The opposite of these conditions will cause necessarily a loss in efficiency more or less pronounced according to circumstances.

EVAPORATION PER POUND OF COAL.

The efficiency of a boiler is often roughly estimated by the number of pounds of water evaporated into steam per pound of coal burned on the grates. This, according to conditions, may vary from 6 or 7 to perhaps 11. Remembering that it usually requires rather more than 1,000 heat units per pound of steam, the general agreement between these figures and those above for the heat utilized per pound of coal is readily seen. In fact, the figures for the heat utilized are derived really from a measurement of the pounds of steam evaporated per pound of coal, together with a knowledge of the heat required per pound of steam, the latter being derived, of course, from the conditions of the evaporation.

When we remember the great difference in the amount of heat required per pound of steam, depending on the temperature of the feed, the temperature of the steam, and whether the steam is moist or dry, it is clear that for any fair measure of boiler performance in terms of steam formed per pound of coal, these differences must be allowed for, especially in comparisons between boilers working under different conditions.

To this end it is customary to reduce the number of pounds evaporated to what it would be if the steam were dry and the temperature of both feed and steam were 212 degrees. In such case it would require to make one pound of steam simply the latent heat at 212 degrees, or 966 B. T. U. (British thermal units).

This is known as the reduced evaporation, or the equivalent evaporation from and at 212 degrees. It is really the number of pounds of steam which would be formed if each required 966 B. T. U., and is, therefore, simply a measure of the B. T. U. put into the steam per pound of coal.

The ratio between the number of B. T. U. actually required and the 966 is known as the *factor of evaporation.* These factors are often arranged in tabular form, assuming dry steam in each case, but with temperature of feed water and steam varying over the usual range.

POCKET BOOK.—An Electrical Pocket Book for 1901 has been gotten out by the *Practical Engineer*, of Manchester, England, as a sort of companion volume for the Engineers' Pocket Book issued by this publication. This is the second year of publication of the Electrical Pocket Book, and it is about the most complete work of the sort published at anything like the price, which is one shilling and sixpence. It contains nearly three hundred pages and covers a wide range of application of electricity, including lighting, power, etc.

EMERGENCY REPAIRS OF ELECTRICAL MACHINERY ON BOARD SHIP.—I.

BY WM. BAXTER, JR.

When an electrical machine becomes disabled, the injured parts may be so seriously affected that nothing short of complete reconstruction will render them operative again; but, on the other hand, the damage may be so trifling that it can be readily remedied if we only know how. It is probably prefectly safe to say that in the majority of instances, the breakdown is due to a defect that can be remedied, at least temporarily, without the assistance of the repair shop. When a ship is on the high sea repair shops are not available, hence it is very desirable to find out how to get along without their aid, and the object of this series of articles is to give such information. We do not propose to consider at all the manner in which permanent repairs should be made, but simply the expedients that may be resorted to to keep the machine in operation until a port is reached where permanent repairs can be effected.

The part of an electrical machine that is the most likely to get out of order is the armature, and the principal causes of trouble are broken wires and short circuits. The way in which these defects affect motors and generators are different, therefore we will consider the two types of machines by themselves. We will first consider the effect of broken wires in the armature of a generator.

If the generator is of the two-pole type it will not build up a current when started, if there is a broken wire in the armature. This, however, is not the only cause which prevents a generator from delivering a current, but as it is one of the most likely ones, it is desirable to know how to detect it.

If we connect a wire with one of the brushes and press the free end against the commutator surface some distance ahead of the brush, as indicated by the broken line *a* in Fig. 1, and a current flows, we can rest as-

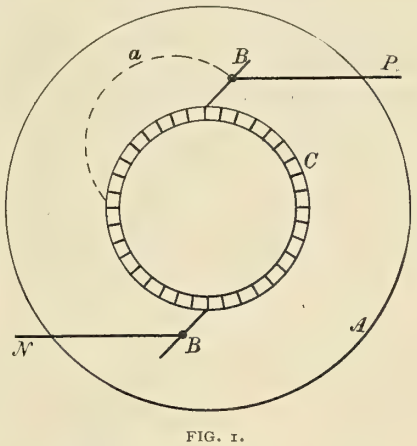

FIG. 1.

sured that failure of the machine to act is due to a broken wire in the armature. The reason why with the aid of the wire *a* the armature will function can be made clear with a brief explanation. Suppose we were to take a ring armature and saw the core apart in two places so as to be able to withdraw the armature coils without disconnecting them. Suppose we

also removed the end clamping ring from the commutator, so as to remove the segments without disconnecting them from the ends of the armature coils. Then, if we stretched out the wire so as to form a large loop it would present the appearance of Fig. 2,

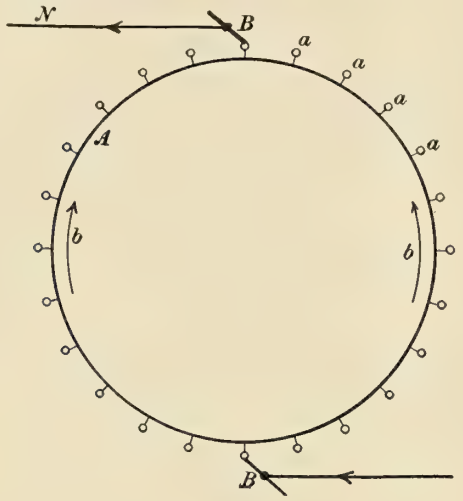

FIG. 2.

in which the circles *a a a* represent the commutator segments, and the large circle *A* the wire forming the armature coils, each coil being represented by the portion of this circle between the lines connecting with consecutive segments. In this figure the lines which connect the commutator segments *a a a* with the armature wire, are shown of a length which is a large proportion of the length of the coils themselves, so that the drawing is greatly out of proportion, but to be in true proportion the circles *a a* that represent the commutator segments would have to be almost in contact with circle *A*, which represents the armature coils. From this it can be seen that we can use a single circle such as *A* to represent the wire and also the segments, if we only keep in mind that points located at regular intervals represent the segments, as in Fig. 3. In this last figure let the gap, at *a*, represent a break in the armature wire, then by comparison with Fig. 2 we can see what effect it will produce upon the distribution of current. In Fig. 2 we see that the current entering through the lower brush divides into two parts, and these pass through the armature coil on the right and left sides, as indicated by arrows *b b*, coming together again at the upper brush. In Fig. 3

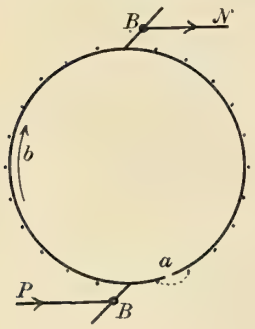

FIG. 3.

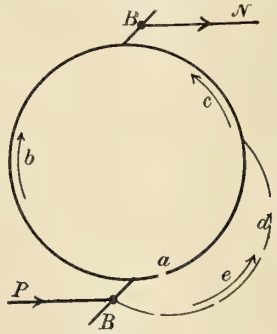

FIG. 4.

only one of these currents can pass through the armature coils, for the circuit on the right side is broken at *a*. Suppose the armature is rotating in the direction of the hands of a clock, then as soon as the break *a* passes the lower brush, the current on the left side of the armature will break, and a new current will start through the coils on the right side; that is, this would be the action if any current flowed, but the very shifting of the current from one side to the other prevents it from flowing. Suppose a current could flow, then this current would magnetize the armature core, and when the break *a* passes the lower brush the magnetization due to the current flowing through the wire on the left side will die out, and a magnetization in the opposite direction will be developed by the current that will now flow through the coils on the right side. These reverse magnetizations would act to develop currents in a direction opposite to that of the current we have assumed to be flowing in the coils; hence, they would kill it, as the two actions would be equal and opposite. Now suppose we connect a wire with the lower brush and press its free end against the commutator in the manner indicated in Fig. 1, then the conditions will be as represented in Fig. 4, in which *d* is the supplementary wire. In this figure we see that by the aid of this wire we have two circuits between the brushes during the time the break *a* is passing from the lower brush to the point where wire *d* touches the commutator, the circuit on the right side being through *d* and a portion of the armature coils, as indicated by the arrows *c* and *e*. During this time a current will be generated, and although during the remainder of the time there will be a reacting current developed, just as in Fig. 3, the action will be greater than the reaction, and as a net result a small current will be produced.

When the commutator segment, which is connected with the end of the coil in which the break *a* is located, passes from under the end of wire *d* a large spark will be produced, and as this will occur once in each revolution, the appearance to the eye will be that of a large flickering spark. After running the machine for a few seconds in this way, if we examine the commutator surface we will soon find two segments between which the burning effect of the spark is plainly shown, while at all other points the segments will be smooth.

Thus it will be seen that the wire *d* not only enables us to determine whether there is a broken wire, but also tells us where it is; that is, in which one of the coils it is located.

If there is a broken wire in the armature of a motor, the machine will run owing to the fact that the current supplied to it will not be reduced by reason of the break. The force with which the armature rotates will be reduced, as only one of the two circuits will be effective, but the only indication of trouble, as a rule, will be the flickering spark at the commutator.

A broken wire in the armature of a multipolar generator may not prevent the generation of current. If the coils are connected with the commutator in series, or "wave winding," the action will be the same as in a two-pole machine, and no current will be generated, but if the coils are connected in parallel, or "lap wind-

ing," a current will be generated. The difference between the action in the two types of winding is due to the fact that with the wave winding the wire on the armature is so connected that there are but two circuits through which the currents can circulate, precisely the same as in the two-pole machine, but with the lap winding there are as many circuits as there are poles; hence if there is a broken wire it only renders one of the several paths useless, and this will not prevent the others from acting. Why this is the case can be understood from Fig. 5, which shows diagramatically the coils of an armature of a six-pole generator. In such a machine, with a lap winding, the armature currents will pass out through three brushes and enter through the other three, as is indicated in the drawing by the arrrowheads. Through the wire coils the currents will flow in the directions indicated by arrow *b c d e f*. The break in the wire at *a* will prevent the flow of current in one of the sections of the armature, but it will not interfere with the other five. The current generated will be unsteady, owing to the fact that through one of the brushes in each set the strength of current will only be one-half of what it is in the others, and this weak current is transferred from brush to brush as fast as the armature revolves.

The broken wire in a multipolar armature causes a flickering spark at the commutator, just as in the two-

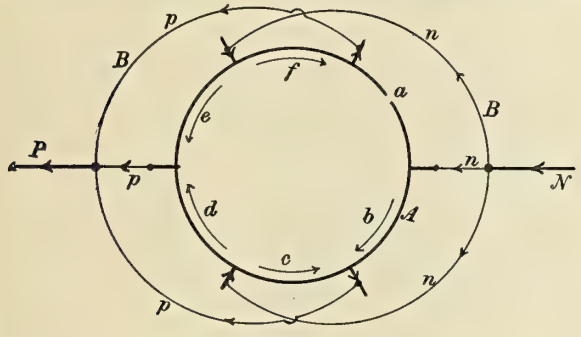

FIG. 5.

pole machine. By the appearance of this spark, we can tell what the cause of the trouble is, and an inspection of the commutator surface will enable us to readily locate the coil in which the defect is located.

To repair an armature in which there is a broken wire is a simple matter in any case, that is, to "doctor it up" so that it will run until a permanent repair can be made. If the machine is small, so that the armature wire is not over an eighth of an inch in diameter, the break may be located at some point in the interior of the coil, and in that case the only permanent cure is the removal of the defective coil; but if the wire is large, or if flat rods are used instead of wire, the temporary patching up we are about to explain will really be a permanent repair.

When the wire is larger than an eighth of an inch, it seldom breaks in the body of the coil, so that in ninety-nine cases out of a hundred we will find that the trouble is due to a defective connection of the coil ends with the commutator segment. These connections are made either with solder or screws, so that to make them tight again is a simple matter, and when this is done the defect is removed.

If the armature coils are made of flat bars they may be in continuous strips from end to end of coil, or the coil sides may be formed of seprarate strips, these being fastened together at the ends so as to make a continuous wire or coil. In some machines these joints are made with solder, in others they are riveted, and in others they are both riveted and soldered. As with coils of this construction, the bars are of large size; they are generally so located that the ends where the joints are made can be easily reached.

If the wire on the armature is small the break may be located within the body of the coil. In such cases the defect will be located at one of the corners of the coil, and may in many instances be found by examination. If the break can be reached, it may be repaired in several ways, such as by splicing, slipping a sleeve over the ends, etc. If the break cannot be found, or if it cannot be readily reached when found, then the proper course to pursue is to cut the defective coil out of the circuit. To accomplish this latter result all we have to do is to connect the two commutator segments between which the sparking has left its mark. This can be easily done by simply soldering a piece of sheet brass or tin to the two shanks. This connection between the two adjoining commutator segments closes the armature circuit by cutting out the coil in which the break is located, and it is indicated in Fig. 3 by the dotted lines around the break *a*. Inasmuch as the coil cut out by this arrangement is open circuited, there is very little danger of any trouble resulting thereafter, and everything will go satisfactorily in almost every instance. It is possible, however, for the vibration of the wire to at some time bring the ends of the broken coil into contact, and then as the extreme ends of the coil are connected by the bridging piece, soldered to the commutator segments, the coil will be short circuited, and a current will be developed in it of such strength as to be able to heat the wire to the charring point, and thus damage the insulation of the adjoining coils. On this account it is advisable to disconnect the ends of the defective coil from the segments. In doing this care must be taken not to disconnect the wrong ends. There are two ends connected with each segment, and these belong to different coils. The two ends of the defective coil will be connected with the two segments that have been bridged. If the four ends connected with these two segments are taken out and tested with a bell or galvanometer it will be found that through two the circuit is complete, but through the other two it is open. These latter are the ends of the defective coil, and they should be covered with insulation and be bent into a position where they will be out of the way and not liable to be dislodged when the armature is in motion. The other two ends must be reconnected with the commutator segments.

The company owning the largest amount of steam tonnage afloat at the present time is the Hamburg-American (German) line, with 286,945 gross tons; next comes the Peninsular and Oriental (British), with 279,597 tons. The International Navigation Co.'s tonnage is 116,950 gross tons, but there are several new vessels under construction for this company which will bring up the total considerably.

ENGINEERS' DICTIONARY.—XXXII.

Packing Screw.—A rod with corkscrew end for removing soft or fibrous packing from the packing space about piston and valve rods.

Paddle Shaft.—The shaft of a paddle wheel engine, carrying the paddle wheels at its outer ends.

Paddle Wheel.—An arrangement of floats carried on a framework and mounted on a shaft as in the figure, the whole forming a means whereby the water about a ship can be taken hold of and driven aft, thereby obtaining a propulsive thrust for propelling the ship. Paddle wheels are of the chief varieties, radial and feathering. In the radial wheel as in the figure the floats are rigidly attached to the framework and enter and leave the water with some obliquity, depending on their greatest depth of immersion. In the feathering paddlewheel the floats are pivoted and connected by a form of linkwork so that they enter and leave the water more nearly in a vertical plane, and there is therefore less loss by oblique action. See under *Feathering Paddlewheel.*

Parallel Motion.—In early forms of the steam engine the *parallel motion* took the place of the *guide* on the modern types. The purpose was to guide or constrain the outer end of the piston rod to move in a straight line, and thus take the side thrust coming from the obliquity of the connecting rod. This was done approximately by connecting the end of the rod to some form of linework so proportioned and adjusted that for the stroke of the engine the path followed by the guided point would be very nearly a straight line. One

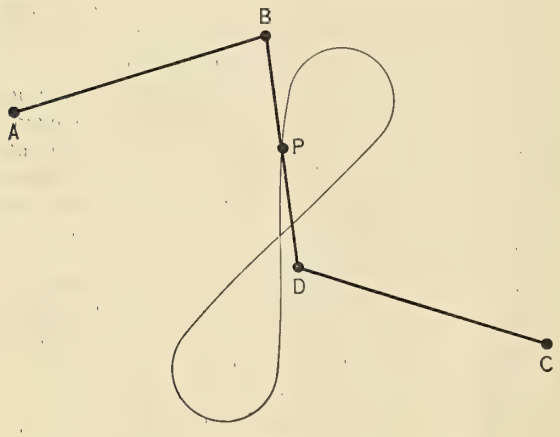

FIG. 91.

form of such linkage is shown in the diagram of Fig. 91, *A* and *C* are fixed centers about which the rods *A B* and *D C* are free to turn. These rods are connected by the link *B D*, and the piston rod is jointed to a point *P* of this rod. The entire path of the point *P* for all possible configurations of the linkage is given by the dotted line, and from which it may be seen that near the point of crossing, it is very nearly straight. The end of the piston rod being thus guided along this approximately straight path, the necessary conditions were practically fulfilled. In modern steam engine practice the use of the parallel motion has almost entirely disappeared. It is still used, however, in various forms on the steam engine indicator, and for other special purposes.

QUERIES AND ANSWERS.

(Communications intended for this department will not receive attention unless accompanied by the full name and address of the sender, which will be considered confidential.)

Q.—Since one horse power is equivalent to the energy necessary to raise 33,000 lb. one foot in height in one minute, A contends that it requires one minute to develop that amount of horse power. Or, in other words, an engine develops so many horse power per minute. B contends that an engine develops the horse power calculated at each revolution, and that a minute of time is only a factor used to determine the piston speed. Which is right?

Would you also please answer the following: An engine develops 1,500 I. H. P. and the coal consumption is 3,000 lb. per hour. What is coal consumption in this case per horse power per hour? A AND B.

A.—The statement of your question is somewhat in error in the first sentence. *Energy* is of the same nature as *work*, but not of the same nature as *power*. Energy and work are measurable in terms of a weight lifted through a certain distance. That is, the energy expended to raise 33,000 lb. one foot high is 33,000 ft. lb., and that is all there is to it, no matter whether it takes one minute or one year to do it. On the other hand power is the capability of performing work in a given time.

Your first sentence should, therefore, read: "Since 1 H. P. is equivalent to the *power* necessary, etc."

If then an engine is developing 1 H. P., it simply means that it is working at such a rate that in one minute it will do 33,000 ft. lb. of work, or raise 33,000 lb. 1 ft. high. The difficulty which is frequently met with regarding the true significance of the term H. P. is largely due to the fact that it is not work itself, but a *rate* of doing work. Suppose we say that a man is walking at the *rate* of three miles per hour. Then while it is true that it will take him one hour to go the three miles, nevertheless he may be said to be walking at the *rate* of three miles per hour for every moment of the hour, and for every foot of the distance. So an engine which is working steadily at the rate of 1 H. P. will have to work for one minute to do 33,000 ft. lb. of work; nevertheless it is working at the rate of 1 H. P., or developing 1 H. P., during every second of the minute, or during every stroke and revolution of the engine.

It follows that A's claim that it requires one minute to develop the horse power is not correct, since the engine is working steadily at that rate throughout the entire minute. Suppose we ask, how long does it take a 1 H. P. engine to develop 1 H. P.? A now would say one minute; but in reality there is no answer or meaning to the question no matter how simple or natural it may sound. It is the same as though we should ask, how long does it take a man to walk three miles per hour?

On the other hand B's claim that the engine develops the calculated power at each revolution is also incorrect, or at least unmeaning. The engine is simply working at the rate of 1 H. P., just as our man is walking at the rate of three miles per hour, and that is all there is to it.

The minute is used, of course, as a factor in determining piston speed, because in order to find the horse power we need to find the work per minute, and then divide by 33,000, thus finding the rate of work expressed in horse power In just the same way we might measure in feet the distance a man walks in one hour, and then divide by 5,280 to find the rate at which he is walking in miles per hour.

In regard to the coal consumption, if the horse power is 1,500 and the coal is 3,000 lb. per hour, then the coal per horse power per hour is 3,000 ÷ 1,500, or 2. This simply means that to feed the engine for one hour we must supply the furnaces with 2 lb. coal for every horse power developed.

Advices from Turkey report the decision for an order for a Turkish cruiser to be placed with the Cramps, the appropriation to include $115,000 as indemnity for losses sustained by U. S. citizens in the Armenian massacres.